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ABSTRACT

This resource book is one of a series of three information resources containing ideas about instructional technology applications and how certain technology applications may have particular relevance to vocational education. It also presents issues important for vocational educators to consider in using instructional technologies. The handbook is divided into seven chapters. Following an introduction in Chapter 1, Chapter 2 provides a background in instructional technology in general, with a focus on defining the concept. Chapter 3 describes the results of a survey about instructional technology applications in vocational education in Illinois. The chapter also provides an inventory of sources for more information about technology applications in vocational education throughout the nation. The remaining four chapters contain descriptions and analyses of four instructional technology applications that are relevant to the future of vocational education: video, microcomputers, interactive video, and integrated information systems. Each chapter contains a description of a technology, an analysis of its potentials and limitations, and ideas about how a given technology might be used to enhance the quality and effectiveness of vocational education programs. Forty references are included. (KC)

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Instructional Technology Applications in Vocational Education: A Sourcebook of Ideas

Illinois State Board of Education

Adult Vocational and Technical Education

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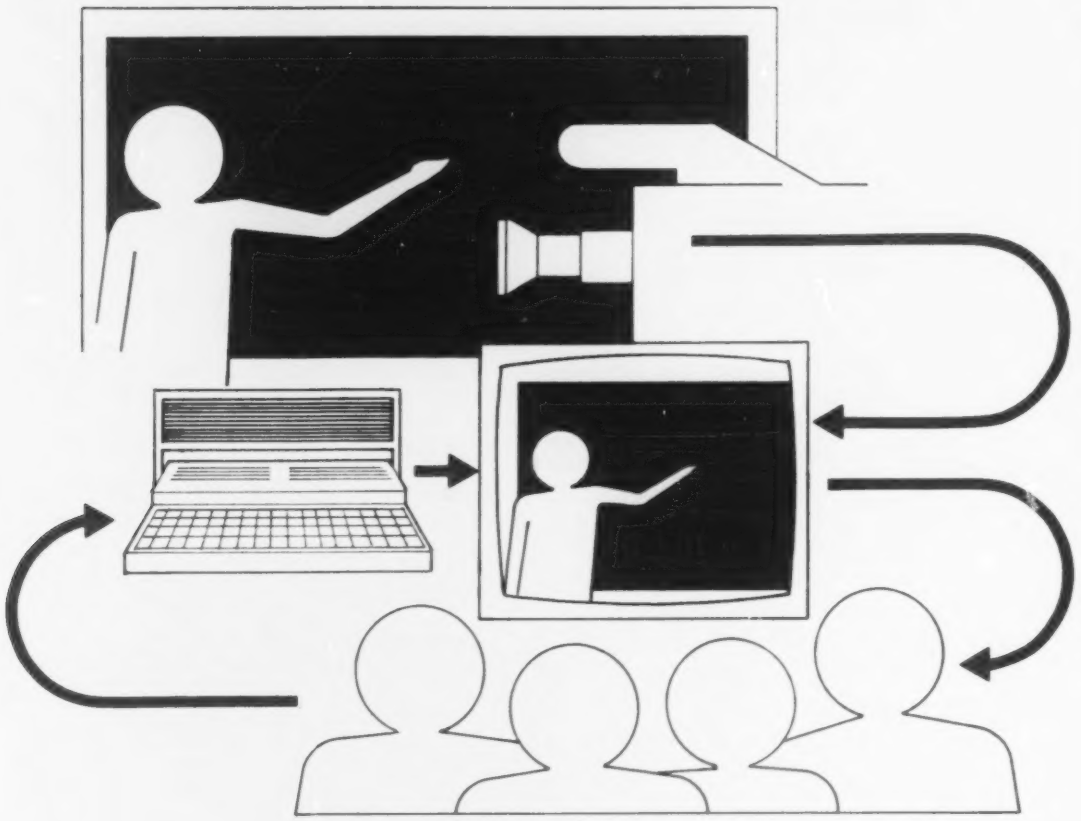

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CHAPTER 1

Introduction to the *Sourcebook*

Vocational educators are very sensitive to technological developments, since these developments often impact directly on the character of work and the nature of the workplace. While most educators are affected by some form of technology, vocational educators are uniquely susceptible to technologically–driven changes. Technology, in some respects, is the very substance of the vocational educator's craft.

Since the time of recorded history, change has been a part of the experience of human societies. The pace of change has not always been as great as we see today, but change has always existed. For much of our history, change has been stimulated by technology developments. Most recently, technology developments and change have both accelerated in speed and complexity. Isaac Asimov, one of our more gifted science (and science fiction) writers, recently observed:

> *There inevitably came a time when the rate of technological advance became fast enough to be seen by people in the course of their own lifetimes; when the fact of change could no longer be denied; when it could be seen with the living, naked eye, rather than through the long glass of history. (Asimov, 1985, p. 11)*

Concurrent with technological developments, needs evolved for changing how people live and work. Those needs fostered questions concerning our schools' (and our education systems') attempts at preparing people to function effectively in a complex and changing society. Central to these questions are concerns of how, as well as what, we are teaching our young people. Vocational educators, who historically have shouldered responsibility for preparing people for the challenges of work and career, are also affected by these questions about education.

Into the scene of technology–induced change and the implications of those changes for the character of education comes another technology factor: the instructional applications of technologies. As various technologies have been created and refined, some are thought to be potentially useful in providing better instructional opportunities for learners. Advocates have touted their favorite technology as the solution to many types of educational problems. Sometimes these advocates have had a financial stake in a certain technology; for example, a vendor selling overhead projectors. In other cases, people have become advocates for a certain technology for philosophical reasons or as a result of their own experiences. Whatever the motivations, some people

and some agencies have tried to convince educators of the merits of a given technology.

Vocational educators thus face demands to respond to technology developments in at least two ways. First, they need to examine the content or substance of what they teach. They must insure that students are being adequately prepared to live and work in a society in which dramatic changes routinely occur. Second, vocational educators must consider ways in which technologies might be used in the instruction process to facilitate student learning. These demands have led to a certain amount of confusion, anxiety and frustration in the professional lives of many vocational educators. This situation may become more complicated in the future: virtually every shred of evidence suggests that technological developments will continue to accelerate; changes as a result of these developments will continue apace; schools and other educational institutions will be monitored for increased accountability; and instructional applications of technologies in vocational education will be demanded, expected, and advocated at a correspondingly rapid pace. How will vocational educators cope with these challenges?

Vocational educators need information resources regarding applications of instructional technology systems. The best way to cope with technology change and to make informed choices about technology applications in vocational education is to systematically examine technology alternatives and their respective implications for education for employment. A wealth of information awaits vocational educators on topics related to instructional technology applications. We hoped to help them sort through this mountain of information and glean that information most relevant to them.

To that end, we have prepared three information resources for vocational educators under a grant from the Department of Adult, Vocational, and Technical Education of the Illinois State Board of Education. The first resource, the *Sourcebook* you are currently reading, is a source of ideas about instructional technology applications and how certain specific technology applications may have particular relevance to vocational education. Also presented are issues we believe important for vocational educators as they contemplate using instructional technologies.

The second information resource we have prepared is entitled *Instructional Technology Systems Applications in Vocational Education*: A Notebook of Cases. This notebook contains lengthy descriptions of some instructional technology systems applications that are currently in use. It is our opinion that vocational educators can profit from learning about instances where technologies are not just being talked about, but are actually being used.

Finally, we have prepared a *Handbook* designed to help vocational educators make decisions about which technologies to use in their particular instructional settings. This handbook will help the vocational educator explore practical aspects of selecting and using instructional technologies.

This *Sourcebook* is divided into seven parts. Chapter 2 provides the reader with a background in instructional technology in general, with focus on definition of the concept. Chapter 3 describes the results of a survey about instructional technology applications in vocational education in Illinois. Chapter 3 also provides an inventory of sources for more information about technology applications in vocational education throughout the nation.

The remaining chapters contain descriptions and analyses of four instructional technology applications that are relevant to the future of vocational education: microcomputers, video, interactive video, and integrated information systems. We have attempted to give the reader a description of each technology, an analysis of potentials and limitations of the technology, and ideas about how a given technology might be used to enhance the quality and effectiveness of vocational education programs. At first blush, these topics may sound like an inventory of hardware. As is suggested in Chapter 2, hardware ought not be viewed as synonymous with instructional technology. Chapters 4–7 do draw attention to both hardware and software, but it does so in the broader context of designing effective teaching and learning programs.

This document was carefully named a *Sourcebook of Ideas*. We have attempted to provide some food for thought, not a prescription for action. This volume, coupled with the two documents previously mentioned, should provide vocational educators with a way of thinking about instructional technologies and some basic information to enhance that thinking. Anyone who suggests single or simple answers to improving vocational education

programs should be greeted with skepticism, and maybe even scorn. We do not have the simple answer: the *Sourcebook* is aimed at helping you, the reader, better arrive at solutions that make sense for your setting. If the *Sourcebook* makes you a more informed potential consumer of instructional technology possibilities, we have succeeded.

CHAPTER 2

Instructional Technology Definitions, Content, and Expectations

Definitions of Instructional Technology

Just what is this thing called instructional technology, this idea that so many people seem to be talking about? Is instructional technology audio–visual aids? Or media? Is it tools? Or, to be more modern, is instructional technology computers? Is anything really new in conversations about technologies and education, or is it the same old stuff we have heard for years? When school administrators, school board members, or authors of books suggest using instructional technologies, what do they really mean? In short, how is instructional technology defined?

These are practical, reasonable, and straightforward questions that vocational educators should ask those who suggest using instructional technologies. Unfortunately, simple answers do not exist, not even for something as concrete as a definition for instructional technology. Defining the concept of instructional technology has posed problems for several years. Some progress in definition has been made. The following narrative provides parameters for a definition of instructional technology.

In 1968, Dr. Paul Saettler wrote a book titled *A History of Instructional Technology* (Saettler, 1968). Saettler provided a broad overview of the development of instructional technology. He described two major schools of thought about the meaning of instructional technology: the physical science and the behavioral science approaches.

The physical science idea of instructional technology centers on media such as teaching machines, television, etc. As Saettler put it, the physical science view of instructional technology regards the various media as "aids to instruction and tends to be preoccupied with the effects of devices and procedures, rather than with the differences of individual learners or with the selection of instructional content." (p. 2) This view of instructional technology as primarily machines and their effects is contrasted by Saettler with the behavioral science concept of instructional technology, which holds that:

> *... educational practice should be more dependent on the methods of science as developed by behavioral scientists in the broad areas of psychology, anthropology,*

sociology, and in the more specialized areas of learning, group processes, language and linguistics, communications, administration, cybernetics, perception, and psychometrics. Moreover this concept (of instructional technology) includes the application of engineering research and development (including human factors engineering) and branches of economics and logistics related to the effective utilization of instructional personnel, buildings (learning spaces), and such new computerized machine systems as data processing and information retrieval. (p. 5)

While Saettler's treatment of the definition question is much more elaborate and thorough than we capture here, the basic difference in definition seems to be that one focuses on the machines or things of instructional technology, while the other definition focuses on the processes of teaching and learning and the applications of machines and other strategies in those processes.

Saettler's history of instructional technology helped a great deal to provide some definition to the concept and the field, but more work was needed. A major effort to provide clarity of definition was undertaken by the professional association most closely linked with practitioners of instructional technology, the Association for Education Communications and Technology (AECT). AECT formed the task force on Definition and Terminology, which worked long and hard, involved a large number of people, and published its findings in 1977 (AECT, 1977). The task force made many contributions to the task of defining the concept of instructional technology, but for our purposes, the most significant findings included:

1. Educational technology was defined as "a complex, integrated process involving people, procedures, ideas, devices, and organization, for analyzing problems and devising, implementing, evaluating, and managing solutions to those problems, involved in all aspects of human learning."
2. Instructional technology was defined by the task force as "a complex, integrated process involving people, procedures, ideas, devices, and organization, for analyzing problems, and devising, implementing, evaluating and managing solutions to those problems, in situations in which learning is purposive and controlled."
3. The domain of instructional technology was described by the task force as consisting of instructional management functions, instructional development functions, and instructional system components. Instructional management functions, such as organization management and personnel management, impact on instructional development functions, such as design, production, evaluation– selection, etc., which in turn impact on instructional system components such as message, people, materials, devices, techniques, and settings, which in turn impact on and are influenced by the learner.
4. Task force writers argued that the definition of educational technology constitutes a theory by virtue of satisfying a number of criteria for being a theory.

Confused? Of course, we have not done justice to the work of the task force in this brief summary. The volume outlining the thinking of the task force contains the kind of detail necessary to support the definitions provided. For the vocational educator, however, one important outcome of the work of the task force is that instructional technology needs to be viewed as an integrated system. That is, instructional technology is not only hardware, or software, or machines or devices or things. Instructional technology involves looking at how people learn, in what kinds of settings and with what motivations and purposes, and using what kinds of materials, devices, or strategies. Integration of resources and learning strategies is the prevailing concept. Thus, advocating uses of instructional technologies is synonymous with advocating the purchase of a microcomputer, or a compact disk, or any other piece of machinery. Instructional technology involves looking in a systematic way at what you are trying to accomplish, for what purposes, and in what ways, and asking how you as teacher, and the student as learner, can best get to where each wants to go.

Many writers have attempted to define instructional technology. Selecting one definition over the others is arbitrary, but we think vocational educators might find the definition provided by Heinich, Molenda, and Russell (1985) helpful: The principal definition of technology used in this book refers to "the systematic application of scientific or other or-

ganized knowledge to practical tasks." Adapting this definition to instruction, we may define instructional technology as the application of our scientific knowledge about human learning to the practical tasks of teaching and learning (p. 19).

Throughout this *Sourcebook* the reader will find references to the "things" of technology (e.g., microcomputers), but we have tried to emphasize that the tools and hardware available to educators do not in themselves constitute instructional technology. The systematic attempt to apply to given learning tasks and objectives what is known about human learning and development, and what is known about hardware, software, and design strategies, constitutes the domain of instructional technology. These correlations comprise the most important considerations in looking at possible technology applications in vocational education.

The Content Foundation of Instructional Technology

The preceding discussion of definitions indicates that the concept of instructional technology is quite eclectic; that is, the content of instructional technology is drawn from many sources. Educators may question whether something may be uniquely identified as instructional technology. Instructional technology writers have acknowledged that their work is influenced by many fields, and they believe the integration of content from a variety of fields to solve instructional problems forms the unique nature of instructional technology.

What are some of the fields, or bodies of content, that have influenced the development of the concept of instructional technology? We cannot provide a complete review of literature that bears on this question, but a brief overview of the content foundation of instructional technology might be helpful.

Instructional technology clearly draws on ideas about human learning and development from the field of psychology. Principles of learning and development are fundamental to fashioning effective instructional practices. Behaviorism has been a major influence on the thinking of instructional technology authors and researchers, but cognitive psychology has of late begun to exert influence. Instructional science, a body of knowledge directed not solely at learning, but also at instruction, has emerged from this base in psychology. Evolving notions of instructional design are heavily based in the psychological sciences. Instructional development, also an important and relatively new term, refers to the applications of principles of instructional design to preparing instructional programs and materials. The literature on instructional design and development has increased dramatically during the past decade.

Communications theory and research represents a discipline of great importance in instructional technology. Communication is central to education and instruction. In attempting to design effective instructional programs and materials, it is important to understand the basic fundamentals of communications theories. Use of various media, such as computers or television, increases the importance of communications theories in instructional technology. Authors and researchers in communications have profoundly impacted the concept of instructional technology.

The field of management or administration has also played a role in the development of the concept of instructional technology. Instructional management is important when applied to the learning efforts of a single individual. Similarly, project or institutional management is important in any effort to provide education on a mass scale, particularly when the effort uses a media. Using media to provide instructional opportunities requires management throughout the processes of designing and developing learning materials to providing learners various learning opportunities. Managing an instructional technology–based system within a school context requires considerable attention to administrative matters. Instructional technology systems become misused or unused unless they benefit from effective management strategies.

Applications of instructional technologies also call upon research and evaluation theory and practice. Research about technology applications informs the design and development of those applications and forms the content foundation upon which design decisions ought to be made. Evaluation is used to test instructional strategies in the early stages of development and to assess the extent to which instructional technologies, work, for whom, and under what conditions. Both research and evaluation methodologies have evolved over time and are a rich

source of theory and practical knowledge for those who wish to design and use instructional technologies.

As computer and telecommunications technologies become more common in education settings, information theory becomes an increasingly important body of content in the domain of instructional technology. Computer science has already made a substantial impact on instructional technology and, rapidly, theories and concepts of information processing and utilization are having similar impact. The growth of information technology applications in education (an example of which you will find later in this volume) also brings with it questions of public policy, which sociologists, political scientists, and others consider important. Related to understanding policy issues, but also important in planning for technology efforts, work in futures has a part in the instructional technology picture.

Engineering has always been part of the scheme of things in instructional technology and continues to exert influence on the character of the enterprise. Advances in electronics technologies have been particularly influential in recent developments in instructional technology. Developments in electronics technologies will continue to impact the future shape of instructional technology in profound ways, much as microcomputer technologies have already done.

This inventory of bodies of knowledge relevant to instructional technology could go on. The point must be obvious: instructional technology is about a lot of things and ideas. The primary issue is that instructional technology represents an approach to blending what is known from a variety of fields, and focusing that blended knowledge in patterns that facilitate teaching and learning. In some ways, instruction (or education) applications are by–products of the primary purpose of some of the fields that influence instructional technology. Computer science, for example, goes forward without necessarily being concerned about instructional applications. So, too, do developments in telecommunications technologies or research methodologies or policy studies.

The vocational educator, when asked to consider instructional technology applications in education, is being asked to examine an amalgam of disciplines that may bear on very practical issues in instruction. All of that sounds fine in theory, but what does this talk of disciplines, content areas, and amalgams have to do with the individual vocational education teacher or administrator trying to provide learning opportunities to learners in classrooms in Hebron, Litchfield, Freeport, Mt. Vernon or Chicago, Illinois? What does instructional technology offer vocational educators?

What Might a Vocational Educator Expect from Instructional Technology?

Given the complexity, diversity, and constantly changing nature of the instructional technology field, what might vocational educators reasonably expect from instructional technologies? This question is not unlike the question of the definition of instructional technology: there are many answers, none of which appear completely correct when applied to any given local school district, region, or individual vocational educator. Given that caveat, vocational educators may inquire if a particular instructional technology application features any or all of the following benefits:

1. Permits a teacher to provide individualized instructional opportunities for learners, in a manner that can be managed by the teacher and the learner over a long period of time.
2. Permits learners to work cooperatively as well as independently on learning projects.
3. Permits vocational education teachers to offer content, learning resources, or experiences normally not available to learners.
4. Permits teachers to monitor the progress of individual learners and to use that information regularly as feedback to learners.
5. Provides instructional opportunities on a cost–effective basis.
6. Stimulates the interest of learners in the subject matter in question.
7. Relieves teachers from mundane tasks to spend time on more important instructional tasks.
8. Enhances the quality of professional life of

the vocational education teacher or administrator.

9. Permits learners to exercise a greater sense of control over and responsibility for their own learning.

10. Enables both teachers and learners to make better use of resources for learning.

A single instructional technology system is unlikely to help vocational educators gain all of the above, but vocational educators should insist that any instructional technology advocated for use in their classroom be capable of delivering at least some of these benefits. The application of instructional technologies is not a simple task, nor can it be done without effort. There need to be rewards for the effort: we advocate that vocational educators clearly understand (before the fact) what benefits may be expected from using a particular technology or technology system.

This brief chapter includes our attempt to provide a context for considering instructional technology applications in vocational education. We have offered definitions of instructional technology to emphasize that instructional technology is more than just hardware. Rather, it is a systematic attempt to assimilate what is known about learning and development with what has been learned about engineering, design, communications and other knowledge bases. We have briefly outlined the content areas or disciplines from which instructional technology draws its substance, and we have suggested a few benefits vocational educators might expect from instructional technology.

But what has actually been done with instructional technologies? That, too, is a very broad question. There are hundreds of books, thousands of journal articles, and countless numbers of reports that attempt to describe what happens when technologies are applied in instruction. People spend their entire professional lives researching and using instructional technologies. Graduate programs spew forth hundreds of degree recipients whose professional interests are related to instructional technology. Schools, businesses, professional associations, and other kinds of entities spend large amounts of money trying to use technologies for instruction. We cannot capture all that action in this volume. Instead, we attempt in Chapter 3 to briefly highlight some of the sources which you, the vocational educator, might consult to pursue descriptions and analyses of uses of instructional technologies in vocational education. It is our hope that this incomplete inventory will whet the appetite of the reader for more information on the topic of instructional technology applications. To provide at least one look at how some vocational educators are thinking about instructional technology applications, we will share with you in the next chapter results of a survey of Illinois vocational education planners. Stay tuned!

CHAPTER 3

Uses of Instructional Technologies in Vocational Education

Instructional technologies have been applied in vocational education settings for many years. As is true of educators in other fields, some vocational educators have been enthusiasts for technology applications in instruction, while others have been uninterested, opposed to, or simply unaware of instructional technologies. Some vocational educators have been successful in using technologies for instruction, some have experienced less than satisfying results, and others have limited experience in using technologies in instruction.

In Chapter 3 of this *Sourcebook*, we present two kinds of information regarding the uses of instructional technologies by vocational educators. First, we share the results of a survey of Illinois vocational education directors conducted as part of the Illinois State Board of Education project that supported the writing of this *Sourcebook*. The survey results depict the readiness of vocational educators in Illinois to consider various instructional technology applications. Second, we provide an overview of sources for additional information about ways instructional technologies have been or are being used by vocational educators throughout the country. The sources we mention in this section of the chapter, together with information about instructional technology applications provided in the *Sourcebook*, *Casebook*, and *Handbook*, provide a comprehensive base of material with which vocational educators can make informed decisions about technology alternatives.

A Survey of Illinois Vocational Educators

The ways and extent to which instructional technologies are used by vocational educators is a function of a number of factors: awareness of technological possibilities, interest, availability of technologies, training, availability of support materials; encouragement from administration, etc.. The three documents prepared as part of this project are aimed at increasing awareness of technological possibilities, and creating more interest in the possible uses of technologies for instruction. Given those goals, we were curious to gauge the familiarity of vocational educators with instructional tech-

nologies and how those Illinois educators feel about the potential uses of instructional technologies.

To that end, surveys of selected vocational education personnel in Illinois were conducted during 1988. The surveys were conducted by the Public Opinion Laboratory (POL), one of the divisions of the Social Science Research Institute of Northern Illinois University. The POL has a great deal of experience conducting surveys, using a very sophisticated computer– assisted telephone interviewing system developed for the laboratory.

The first survey involved 57 education for employment planning grant directors in the state of Illinois. Of the 61 individuals holding this position in Illinois, only four did not participate in the survey. Telephone interviews were conducted with each of the 57 planning grant directors, each interview lasting approximately 30 minutes. The interviews were conducted following an interview protocol jointly developed by project staff and POL staff.

The second survey involved community college planning directors in Illinois, individuals who have responsibility for education for employment programs in their respective community colleges. Forty–five planning directors were contacted for participation in the study; 33 individuals agreed to participate and were interviewed, again using a jointly developed interview protocol. Most of the items were common to both surveys. It is tempting to compare and contrast responses from the two surveys, but POL staff warned that statistical comparisons between samples in the two surveys are not appropriate because the sample size within and between groups is too small to yield meaningful information.

The surveys contained many questions, not all of which are important to this *Sourcebook*. However, a review of responses to some of the items provides one means of understanding how this sample of vocational educators is thinking about instructional technology applications.

We have argued that instructional technologies should be viewed in systems terms, that is, as part of a broad picture of teaching and learning. We therefore wanted some sense of what vocational educators regarded as the major instructional problems they faced in their schools or colleges. The planning grant directors highlighted two major problems: money (or lack thereof) and staff development. Community college personnel voiced the same problems, but in reverse order. Money problems, as expected, were largely articulated as underfunding problems: lack of money to do all that is requested of schools. Also, survey respondents acknowledged the need for continuing professional education for teachers and other staff. Presumably, this expressed need results at least in part from the kinds of social and technological changes outlined earlier in this book.

While these two instructional problems are hardly surprising, they do have serious implications for discussions about instructional technology applications. In terms of the money issue, technologies must be affordable and produce cost–effective results. The staff development issue is obvious: teachers and others cannot be expected to use technologies unless they have received adequate training.

For purposes of this *Sourcebook*, the most useful information from the surveys concerned respondents' perceptions of vocational educators' awareness of and receptivity to a number of instructional technology components or systems. Table 1 contains a description of one of the questions asked of planning grant directors and the responses they gave:

Table 1

How would you rate your level of awareness of the following, on a scale from 0 to 10, where 0 is "not informed" and 10 is "very informed?"

	Mean	Mode
Computer–based instruction	6.5	8
Interactive video that uses microcomputers	5.0	5
Systems that integrate multiple information technologies	5.3	5
Broadcast instructional television	5.4	8
Video cassette or disk instruction	7.4	8
Radio instruction	4.9	8
Systems based on artificial intelligence or expert systems	3.0	3

Using mean responses as a guide, it appears that planning grant directors responding to the survey tend to see themselves as relatively familiar with video cassette or disk technology and with computer–based instruction. They rate themselves moderately familiar with the rest of the technology components. Examining the mode response paints a somewhat different picture; mode scores suggest a higher level of self–assessed awareness of most of these technology components among planning grant directors.

Planning grant directors were asked an additional question about these same technology components. Table 2 contains a summary of planning grant director responses.

Table 2

What percentage of secondary vocational education instructors in your region would be receptive to using [technology component]?

	Mean %	Mode %
Computer–based instruction	71	80
Interactive video that uses microcomputers	57	50
Systems that integrate multiple information technologies	48	50
Broadcast instructional television	52	50
Video cassette or disk instruction	72	90
Radio instruction	38	50
Systems based on artificial intelligence or expert systems	30	0

According to planning grant directors, vocational education instructors in their regions are likely to be quite receptive to using video or computer–based instruction, not very likely to use radio instruction or systems using AI or expert systems, and perhaps somewhat receptive to the other technologies. These percentages represent planning grant directors' judgments about how vocational education instructors feel about using these technology components; we do not know how instructors themselves would judge their own receptivity.

Are these technology components feasible? Could they actually be implemented in the regions of the state? Planning grant directors' responses are summarized in Table 3.

Table 3

Now, let me ask you to think about the feasibility of implementing various instructional technologies and methods of delivering education for employment. Again, I would like you to answer these questions in percentages. What percentage of high school students in your region are likely to have regular access to [technology component] in the next five years?

	Mean %	Mode %
Computer–based instruction	72	100
Interactive video that uses microcomputers	38	0
Systems that integrate multiple information technologies	25	0
Broadcast instructional television	41	40
Video cassette or disk instruction	74	90
Radio instruction	37	0
Systems based on artificial intelligence or expert systems	18	0

In terms of how likely it is that students will gain regular access to these technology components during the next five years, planning grant directors are pessimistic, except for the cases of computer–based and video instruction. This is especially true of those technology systems that might be regarded as newly emerging, such as integrated information systems, and, interestingly, radio instruction.

Finally, planning grant directors were asked to judge how much exposure they believe students

have already had to the various technology components. Responses are summarized in Table 4.

Table 4

Let me ask you to think about students' exposure to instructional technologies in education for employment programs. Please use a percentage to respond to the following questions. What percentage of vocational education students in your region are exposed to [technology component]?

	Mean %	Mode %
Computer–based instruction	54	50
Interactive video that uses microcomputers	17	0
Systems that integrate multiple information technologies	13	0
Broadcast instructional television	21	10
Video cassette or disk instruction	60	100
Radio instruction	16	0
Systems based on artificial intelligence or expert systems	6	0

A different picture appears. Between 55% and 60% of the students are judged to have had exposure to computer–based or video cassette/disk instruction in their vocational education classes. For the other technology components, exposure is judged to have been very limited to almost nonexistent. Again, this is the judgment of planning grant directors.

Staff from the POL working with the survey made an interesting observation about the results of the planning grant directors' portion of the survey:

> *There is an interesting pattern in that, with the exception of video cassette or disk instruction, the rating estimations diminish as the questions tap the current status of these resources. Thus, while planning grant directors stated that instructors would be receptive to using these resources and the feasibility of implementing these resources appears positive, examination of current student exposure to these resources sheds light on the discrepancy between future possibilities and the current reality.*

With the POL's reminder to exercise caution in comparing the results from the two surveys, it is interesting to look at how community college administrators of occupational education responded to the same survey questions as given to the planning grant directors. Mean ratings on an absolute scale differed between community college and K–12 directors, but patterns of responses appeared to be very similar. Overall, community college personnel judged their own awareness level on most of the technology components to be a bit higher than planning grant directors, but the relative awareness among the components followed similar patterns, with microcomputers and video cassette/tape instruction being most familiar to both groups. Radio instruction is apparently not a significant technology component in the judgment of either group. In terms of feasibility of implementation, (i.e., perceptions of the likelihood that students in vocational education programs will gain regular access to a technology component over the next five years), the predictions of both groups were almost identical.

Respondents to these two surveys thus report varying degrees of familiarity with technology components and are relatively optimistic about possibilities for applying at least some of the technology components or systems in the future, but are rather more pessimistic about the amount of exposure students are currently getting to instructional technologies. For both groups, money and staff development concerns top the list of instructional problems being faced by vocational educators in the state.

Survey results will always be subject to the bias and motivation of the person or persons interpreting the results. To us, the survey results suggest that vocational education planners have a general sense of what instructional technologies are and can do, but their level of awareness of technology applications can be improved. We also note the reported positive receptivity of vocational education instructors to many of the instructional technology alternatives. This bodes well for future investigations of how technologies might serve vocational education in the state. There is, at least, no indication that voca-

tional education instructors might reject instructional technologies without any consideration. Of course, the two surveys did not involve instructors directly; if asked, instructors may voice a very different opinion about these matters.

Sources of Information about Instructional Technology Applications in Vocational Education

Numerous instances of instructional technology applications are occurring in vocational education settings. Although the range, quality, or effectiveness of those applications are difficult to measure, there is much activity related to technology applications in vocational education. Reading about, or better yet visiting, places that feature creative uses of technologies will help vocational educators perceive applications of instructional technologies in their own classrooms. The utility of information about instructional technology applications, of course, is the premise upon which this *Sourcebook* and the companion *Casebook* is built.

The purpose of this section is to provide a roadmap or guidebook to sources of information about instructional technology applications in vocational education. Using this section, the remaining chapters of this *Sourcebook*, and the material in the *Notebook of Cases*, vocational educators can begin to acquire a working knowledge of technology possibilities in vocational education.

Before proceeding, we remind the reader that many of the most interesting applications of instructional technologies in vocational education are probably not reported in the literature. Individual teachers and administrators, working away in their classrooms and schools, are trying things, experimenting here, testing there, without a lot of fanfare. Those experiences are difficult to discover if you are not inside that particular classroom or school. And in some of those instances, the instructional technology system is not what makes it all work—it is the creative, energetic teacher, the supportive administrator, or curious students that make it all work. In preparing these materials, the authors ran into just such a situation. In Pequannock Township High School, a relatively small school in New Jersey, Ralph Rizzolo is principal of the high school. Ten minutes into our conversation, we knew this school was doing some creative things with instructional technologies in many of the content areas, but perhaps especially in vocational education. The major reason things are happening in vocational education is Andy Vics. To be sure, Pequannock Township High School has hardware and software, but the secret to technology applications at Pequannock is Vics. He uses all kinds of technologies in his vocational education classes, and he has taken discarded PC's and turned them into special purpose machines, such as the one with robot arms. The computer–aided design experiences for students are remarkable. Instructional activities involve students in powerful ways. Andy Vics, working with very ordinary technologies, has transformed the vocational education experience into something quite extraordinary. And, importantly, Andy has the enthusiastic support of Ralph Rizzolo and Ned Davis, the district's computer support person. This is a real success story, largely unheralded but very significant. No doubt there are other Andy Vics in the nation, other success stories to be told.

You may be lucky enough to run into an Andy Vics or Ralph Rizzolo, and you can learn much about applying instructional technologies in vocational education from that encounter. In case you do not have that good fortune, or as a supplement to your good fortune, we offer leads to other sources of information about instructional technology in vocational education.

Clearinghouses and Database Systems

As information about the processes of teaching and learning (and the support systems that surround these processes) has grown, it has become necessary to create systems to store, analyze, and make available to users that information. A subset of the total pool of information concerns instructional technology; another subset concerns vocational education. The subsets of information intersect at various points, giving us information about instructional technology in vocational education. Pinpointing that intersection to find information you want is not always easy. To help with that process, various infor-

mation clearinghouses and database systems have been created. Some of these clearinghouses and database systems contain examples and analyses of instructional technology applications in vocational education.

As a guide to these clearinghouses, the National Center for Research in Vocational Education has produced a publication providing an overview of information resources for education. The executive summary of this overview stated:

> *Intended as a desk reference for persons involved in all aspects of education, this directory contains information on fifty–six online databases and sixty–four clearinghouses. The directory is divided into two main sections, each arranged alphabetically by name. Section I, Databases, contains one–page descriptions and sample records of twelve education databases and three multi– disciplinary databases pertinent to education...Section II, Clearinghouses, contains profiles of education clearinghouses and clearinghouses concerned with education–related topics such as aging, child abuse, drug addiction, disabilities, grants, microcomputers, and women's sports...An introduction, as well as guides to interpreting the database and clearinghouse profiles, list of references, resource index, and subject index complete the publication.*

This valuable guide to databases and clearinghouses is a place to begin searching for relevant clearinghouses and databases. To order this document contact:

> *Databases and Clearinghouses: Information Resources for Education – Fifth Edition*
> Order Number IN 248
> The National Center for Research in Vocational Education
> National Center Publications, Box F
> 1960 Kenny Road
> Columbus, Ohio 43210

Among the clearinghouses containing information potentially useful to vocational educators interested in instructional technology applications, ERIC is perhaps the most important. The ERIC system is composed of sixteen topic–specific clearinghouses, as well as a publications arm. ERIC gathers, codes, and abstracts a wide variety of kinds of information materials about topics in education. Users can conduct searches of the database, using a comprehensive search system available through most libraries. It's possible to obtain abstracts of materials or full copies of the text of materials on either microfiche or paper copy.

Because of the vastness of the ERIC holdings, it is impossible in a document like this *Sourcebook* to provide a comprehensive report on what is available through ERIC on the topic of instructional technology applications in vocational education. Fortunately, some work has already been done to search and summarize ERIC holdings related to our topic. [NOTE: Throughout this section, we make reference to specific publications we have found in our own searching of these sources of information resources. We emphasize that the materials we mention should be taken as illustrative of what might be found using the sources. We have not attempted to be exhaustive in our own search.]

A publication of interest to vocational educators appeared in 1987, entitled *ERIC Update on Educational Technology in Adult, Career, and Vocational Education* (Bibliography Series No. 89). The publication, produced at the National Center for Research in Vocational Education, contains approximately 70 pages of abstracts of articles and reports on instructional technology applications in adult, career, and vocational education. Examples of titles of some of the materials abstracted in this publication include:

> High technology in the vocational areas
> Microcomputers in business education: A look at public and private schools
> High tech/high touch: A synergy applicable to career development
> An agriculture videotext system: The Green Thumb pilot study
> A prototype of CAD/CAM education in the community college
> Instructional strategies for using microcomputers in vocational education

In addition to gathering, coding, and abstracting articles and materials published elsewhere, ERIC clearinghouses also produce bibliographies, research summaries, newsletters, and other forms of publications aimed at making information available to users. Some of these kinds of publications bear directly on our topic. For example, the ERIC Clearinghouse on Adult, Career, and Vocational Education produced a monograph entitled *Communications Technologies: Their Effect on Adult,*

Career, and Vocational Education (IN 244), containing a number of articles on how communications technologies are being used in vocational education. The ERIC Clearinghouse on Information Resources has over the years produced many publications bearing on instructional technology applications. For example, that clearinghouse recently announced the availability of a monograph entitled *A Reappraisal of Instructional Television*, a topic of interest to many vocational educators. Similarly, the publication entitled *Telecommunications–based Distance Learning: A Guide for Local Educators* might prove useful.

In addition to bibliographies and analytical materials, the ERIC system contains numerous case studies or descriptions of technology applications in specific vocational education settings. For example, one ERIC entry is entitled *Final Report: Develop and Demonstrate the Use of Integrated Instructional Delivery Systems for Application in Technical/Vocational Education.* This report of a project in the San Antonio State Hospital would not have been available through any source other than ERIC. ERIC regularly includes reports such as this one, which would go unnoticed by most vocational educators. Of course, ERIC also references articles in journals and other publications. Many of these articles (e.g., an article on "Wisconsin's School of the Air") will turn up in a search done of the ERIC database, but might not otherwise come to the attention of vocational educators interested in the topic.

ERIC is thus a primary resource for information about instructional technology applications in general and in vocational education specifically. The ERIC system can be accessed through many libraries; in addition, vocational educators may wish to contact the two clearinghouses of special interest directly to obtain lists of publications and other information:

ERIC Clearinghouse on Adult, Career, and Vocational Education
National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210–1090
(614) 486–3655; (800) 848–4815

ERIC Clearinghouse on Information Resources
Syracuse University
Schools of Education and Information Studies
Huntington Hall, Room 030
Syracuse, New York 13244–2340
(315) 423–3640

Clearinghouses, and particularly ERIC, are an important source of information about instructional technology applications. In addition, vocational educators can now gain access to other databases that may be of value. Approximately 4,000 electronic data bases are available to people via microcomputers and modems (and the right access codes!) from their schools, offices or homes. These databases have been assembled by businesses, professional associations, and private individuals, and are available to users for certain fees. Given this huge array of databases, on a vast number of topics, some innovative companies have stepped in to provide organized access to these information databases through the form of "information utilities." For example, DIALOG Information Services, Inc., offers subscribers access to nearly 300 data bases. From DIALOG's (1987) Database Catalog:

> *The databases on the DIALOG system contain in excess of 120 million records. Records, or units of information, can range from a directory–type listing of companies, associations, or famous people; to an in–depth financial statement for a particular company; to a citation with bibliographic information and an abstract referencing a journal, conference paper, or other original source; to the complete text of a journal article.*

On–line database services, such as those offered by DIALOG, represent the way educators and other citizens will gain access to information in the future. Information may well become a utility of tomorrow, much as gas or electricity is today. To find out more information about how technologies can be used in their classrooms, vocational educators may need to learn how to use information technologies to gain information about technologies. The prospects of having ready access to great storehouses of information are exciting, if not a bit frightening!

Some of the online database companies/systems that offer information of potential interest to vocational educators include the following:

DIALOG Information Services, Inc.
3460 Hillview Avenue
Palo Alto, CA 94304
(800) 3–DIALOG

BRS
Bibliographic Retrieval Services, Inc.
1200 Route 7
Latham, New York 12110
(800) 833–4707

The Source
Source Telecomputing Corporation
P.O. Box 1305
McLean Virginia 22101–9881
(800) 336–3330

Compuserve
5000 Arlington Centre Blvd.
P.O. Box 20212
Columbus, Ohio 43220

Development/Service/Dissemination Agencies

Clearinghouses and database service companies are certainly service agencies for those needing information. In addition, a number of agencies are engaged in development, service, and dissemination activities that deal with instructional technology applications in a variety of settings. Each of these agencies, within its mission constraints, provides information and in some cases actual instructional materials, technologies, or consulting, to those interested in such services and products. The number of these agencies prohibits a comprehensive inventory within this sourcebook. We do offer some good examples of this kind of organization or entity; readers are urged to contact these agencies for more information about instructional technology applications in vocational education.

Minnesota Education Computing Consortium
3490 Lexington Avenue
St. Paul, MN 55126

Agency for Instructional Technology
Box A
Bloomington, Indiana 47402–0120

Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210

National Diffusion Network
Office of Educational Research and Improvement
U.S. Department of Education
555 New Jersey Avenue, N.W.
Washington, D.C. 20208

Illinois Coordinator:
Shirley M. Menendez
Project Director
Statewide Facilitator Project
1105 East Fifth Street
Metropolis, Illinois 62960
(618) 524–2664

Educational Products Information Exchange (EPIE)
P.O. Box 839
Water Mill NY 11976

In addition to these agencies, a number of centers or offices within universities, colleges, and professional associations provide information or services related to instructional technology applications in vocational education. Here are several examples:

Wisconsin Foundation for Vocational, Technical and Adult Education
2564 Branch Street
Middleton, WI 53562
(608) 831–6313

Training and Development Research Center
University of Minnesota
1954 Buford Avenue
St. Paul, MN 55108
(612) 624–7481

Trade and Other Publications

The ERIC system, other clearinghouses, and database providers generally include citations from trade publications in their databases. Thus, an ERIC search will in all likelihood yield citations from articles appearing in education–related journals, and in many cases will also yield information on other written materials that are not in journals. However,

we thought it might be useful to the reader at this point to have an inventory of publications that are especially useful in identifying instructional technology applications in vocational education. Some of the references below are to journals focused primarily on vocational education, while others are more generally concerned with instructional technology applications and will occasionally feature articles on vocational education applications. In most instances, we have included addresses for anyone interested in subscriptions to the publication in question.

The American Journal of Distance Education
Rackley Building
Pennsylvania State University
University Park, PA 16802

Classroom Computer Learning
Peter Li, Inc.
2451 E. River Road
Dayton, OH 45439

Educational Technology Magazine
Educational Technology Publications, Inc.
720 Palisade Avenue
Englewood Cliffs, NJ 07632

Electronic Learning
Scholastic, Inc.
730 Broadway
New York, NY 10003–9538

Futurist
World Future Society
4916 St. Elmo Avenue
Bethesda, MD 20814

High Technology Business
Infotechnology Publishing Corporation
P.O. Box 53981
Boulder CO 80322

Journal of Extension
432 North Lake Street
Madison, WI 53706

Media and Methods
American Society of Educators
1511 Walnut Street
Philadelphia, PA 19102

Performance and Instruction
National Society for Performance and Instruction
1126 Sixteenth Street N.W.
Suite 102
Washington, D.C. 20036

T.H.E. Journal
Technological Horizons in Education
Information Synergy, Inc.
2626 S. Pullman
Santa Ana, CA 92705

Training
Lakewood Publications, Inc.
50 South Ninth Street
Minneapolis, MN 55402

Training Today
Chicagoland Chapter/ASTD
203 North Wabash Avenue
Suite 1022
Chicago, IL 60601

The Computing Teacher
International Council for Computers in Education
University of Oregon
1787 Agate Street
Eugene, OR 97403–9905

The Technology Teacher
Journal of the International Technology Ed. Assn.
1914 Association Drive
Reston, VA 22091

In addition to the publications listed above, many professional associations and other agencies publish and distribute newsletters that often contain information of interest to vocational educators considering instructional technologies. Again, the number of these newsletters is large, making it impossible for us to provide anything resembling a complete inventory. Following are a couple of examples of the kind of publication we have in mind:

Technical and Skills Training News
American Society for Training and Development
1630 Duke Street
Box 1443
Alexandria, VA 22313

Future Survey
World Future Society
4916 St. Elmo Avenue
Bethesda, MD 20814–5089

Vendors

Vendors are another source of information about possible applications of instructional technologies in vocational education. Companies and individuals that create instructional technology products for the education marketplace also create materials to describe and market their products. While such materials need to be treated with full recognition of their purposes, these materials are nonetheless helpful to the vocational educator attempting to gather information about instructional technology possibilities. We are, of course, reluctant to attempt to list vendors. We can only urge our readers to gather as much information from vendors as possible before making decisions about which, if any, technology system to purchase or lease.

In Chapter 3, we have provided a context for examining some specific kinds of instructional technologies that may have utility for vocational education. A description of the way one group of vocational educators in Illinois assesses the current and possible future status of instructional technology applications in education for employment programs in the state has been described. In addition, we have suggested a number of sources of information about technology applications that vocational educators might wish to consult for ideas about how instructional technologies might enhance their vocational education programs. Now we turn to more in–depth examinations of five instructional technologies which hold promise for vocational education.

CHAPTER 4

Video Technology

A Scenario

To put it mildly, John, age 15, was a video fanatic, and to be perfectly honest, something of a connoisseur. John loved it all: he grew up with television and played the video games with flair and considerable skill. He had mastered the family VCR and Camcorder and had even gained some production skill by getting involved in the school's television operation. John held high standards and expectations for video uses in vocational instruction; he was a video veteran.

John looked forward to most days in school, especially the time spent with Mr. Moor. Moor used video and used it well. Last week, for example, Moor had introduced a new unit of instruction on determining shades and shadows in two–point perspectives in architectural renderings. He showed the class a video prepared by an excellent production company in conjunction with a major architectural firm. Moor stopped the video at several points to engage the class in discussion. Students were asked to begin some research on topics of individual interest. To support that research, Moor had assembled in the Learning Resources Center a number of video cassettes he felt might be useful in students' research efforts. Each student was encouraged to go to the Learning Center during study hall to view tapes of his or her choosing.

During the second week of the unit of study, John participated, together with half a dozen of his classmates, in a video conference with another group of students in a school in Montana. The conference used video and telecommunications equipment that permitted two–way interaction between all the students participating in each of the two schools. Some very interesting ideas were discussed, and each of the students ended the teleconference with a new set of acquaintances!

Another exciting video event occurred during the third week of the unit of study. Moor arranged to have Ms. Clark, an architect in a commercial architectural firm located across the country (the firm involved in the making of the video Moor had used to introduce the unit of study), "bussed in" to the class via a satellite hook–up. Clark first talked to members of the class about how architectural

This chapter was prepared by Dr. Farhad Saba, Associate Professor of Educational Technology at San Diego State University.

renderings are used to promote and sell design ideas and concepts to clients. Students were able to ask Clark nearly an hour's worth of questions and gained information they could not have found in other sources.

Because of Mr. Moor's long–standing interests in video technology, he had been asked to pilot test a new video system unavailable on the general market as yet. The new system permits developers to use video cassettes in the same way interactive video disks have been used: each frame of the video cassette was numbered and a mechanism was developed that permitted individuals, using microcomputers, to access video cassette material frame by frame. The prospects for this new technology are mind–boggling; John and his classmates were among the first to ever use this new technology, and the experience was fantastic.

Of course, as the unit progressed, Mr. Moor used video cassettes, cable television, and satellite communications to open up the world via video to all the students. In no other way could students have viewed the kinds of demonstrations they saw or "traveled" to the places they did. The glimpses the students were given into some of the future forms of video utilization were exciting and certainly gave the students a first–hand experience with the impacts of technology development.

The Growth of Video

In the past two decades video technology has emerged as a ubiquitous communication medium in entertainment, business, education, and training. For example, a national survey (The World Almanac and Book of Facts, 1987) shows that in all American households:

- 98% have at least one television set,
- 53% are wired to cable television, and
- 51% own a video cassette recorder.

Among 229 business and industrial firms surveyed by Brusch and Brush (1986):

- 31% produce video programs using their own equipment and personnel (in–house production),
- 65% produce video programs in–house with some outside resources,
- 3.9% produce video programs with outside sources.

In addition, 41% of all businesses surveyed indicated they also purchase video programs produced by commercial publishers and producers. In–house productions and published programs used by business and industry serve a variety of purpose. Among them are:

- personnel training,
- corporate communications,
- marketing, sales, and advertising,
- patient education, and
- the enhancement of internal organizational communication on a variety of topics ranging from legal affairs to electronic data processing.

The use of video technology in public education is also extensive (Reed & Sutter, 1986). Most K–12 schools own video production facilities and produce their own programs with varying degrees of sophistication. Many schools across the country also receive instructional broadcasts. Students watch instructional programs provided by a variety of telecommunication systems as part of their daily learning activity. Video cassette recorders (VCR's) are also very popular in schools; they are used for recording instructional programs and special events for later showing to students. Moreover, institutions of higher education use video technology to augment classroom instruction and telecast educational programs to off–campus students (Webster, 1984, Moore, 1987).

Popularity of video technology among its users stems from its flexibility and immediacy (Zettle, 1984). Live or pre–recorded programs can be distributed via air waves which make them immediately available to millions of viewers. A simple video program can be produced with a video system consisting of four portable components: a camera, a microphone, a recorder, and a monitor. This combination is also referred to as a small format video system (Compesi & Sherriffs, 1985). Unlike film that requires laboratory processing, video tapes are available for use immediately after recording and editing. Recorded programs can be distributed either by simple means such as through the mail, or through electronic means such as broadcast television, cable television, and communication satellites (Bittner, 1980). If transmitted, broadcast television can be one–way, from the program originator to the audience, or two–way, in which case the audience can talk back to the program

originator and engage in a conversation. Broadcasts can be pre–recorded or live. Live two–way (or multi–point) broadcasts are becoming increasingly popular in business and higher education. These broadcasts are also referred to as teleconferences. Broadcast programs also can be recorded on video tape at home or in school and viewed at the convenience of the user.

These production and distribution possibilities provide flexible and immediate means of communications through pictures and sounds for business, industry, education, and training. Thus, depending on their needs, budgets and audience, video users can choose to work with a simple video system or engage in a more complex studio production. They can distribute their programs through the mail or they can broadcast them. For these reasons, video technology should be of interest to many vocational educators.

Most people are familiar with basic video equipment: a television set (a receiver), VCR's, video tape or cassette, perhaps even video cameras. Many educators are also familiar with basic modes of receiving video programming: cassettes, broadcast TV, cable TV, laser disks, and satellite transmission.

For many settings, the basic equipment of a VCR, receiver, and perhaps a connection to cable or broadcast television is all that is needed by the vocational educator. In other cases, vocational educators may wish to get more involved in producing and distributing video materials. Later in this chapter, a more detailed description is provided of equipment and distribution possibilities. [Note: see the *Notebook of Cases* for an extended profile of the use of one kind of video system, an interactive video system.]

Instructional Applications of Video Technology

During the past two decades, video technology has become smaller, less expensive, and more available in public schools, institutions of higher education, and training departments of business and industries. During this relatively short period educators and trainers have found many innovative ways to use video technology for instructional purposes. In this section, techniques or instructional applications are introduced; those techniques that are or could be used more frequently by vocational educators are highlighted with examples in the next section.

Augmenting Classroom Instruction

Many teachers and trainers use programs broadcast by the Public Broadcasting Service stations (or cable and commercial stations) to augment classroom instruction. Since it is difficult to match classroom hours and instructional subjects to broadcast times, educators use video cassette recorders (VCR) to record programs off the air and show them to their students at convenient times. Off–air recording of programs for "fair use"is legal and possible. However, teachers cannot keep these recordings indefinitely; off–air recordings should be erased after students have viewed the program. Teachers also use videotapes borrowed or rented from film libraries, media centers, and other sources to augment classroom teaching and learning activities.

For a thorough analysis of legal issues involved in off–air recording of educational programs see: Sinofsky, E. R. (1984). Off–air videotaping in education: Copyright issues, decisions, implications. New York, NY: R. R. Bowker.

Producing new instructional programs.

Many teachers find broadcast programs inadequate or unsuitable for their instructional needs and the learning needs of their students. In this case, they use a small format system or even a professional video studio to produce a program according to their own specifications. Video production is time consuming and requires a lot of preparation, but it is an enjoyable activity, especially when teachers involve their students in the production process. Shuey (1976) presented an example of this type of production effort. He reported that when it became clear that there was "a dearth of captioned film dealing with vocational education subjects,"the instructor and the TV department at Kansas State School for the Deaf developed video tapes and other aids that would better help the students. This is but one example of many video programs that educators produce to satisfy their particular instructional needs.

Enhancing Instructional Techniques

Teachers use role–playing and performing to teach literature, history, social science, management, group dynamics, safety, job tasks, and a variety of other subjects. These instructional techniques can be enhanced by video technology. Students can be videotaped while they are engaged in a role play of a work situation, a management simulation, a job interview, or other learning activities. Students can preview these tapes, watch themselves in action, and learn from an objective/subjective observation of their strengths and weaknesses.

Motivating Students

Educators who have involved their students in video production projects report that students show a high degree of motivation in becoming engaged in all aspects of the video production process. For example, Jiji (1986) used video in teaching English to college students and reported:

> *Perhaps the most effective way is to have students create their own miniature television productions. When they do this, their natural desire to become movie moguls is given an opportunity to flower. Their motivational level is extremely high (p.309).*

Since video production is by necessity a cooperative venture, participating students not only learn how to put a video program together, but they also improve their social skills in organizing, participating in, and leading a group activity.

Evaluating Student Performance

Video can provide objective recordings of how students perform observable practical tasks. Educators in physical education, speech communication, performing arts, and vocational and technical training can make video recordings of their students as they perform specific tasks. Special features such as instant replay, slow–motion, and freeze frame are used for evaluating students' performances as well as for providing corrective feedback to them. These features are also used to catalog performance samples, standardize measurement and grading criteria, train evaluators, and develop criteria for screening new candidates to enter a specific field (Hayes & Pulliam, 1974).

Substituting Field Trips and Science Experiments

Video technology, in many instances, eliminates time and distance in the instructional process. Field trips are an effective instructional technique for a variety of subject areas in basic and social sciences. But time and distance may prohibit visiting far away sites. Videotapes can bring sights and sounds of diverse geographical areas to the classroom. Historical events recorded in documentaries—as well as in some feature films—can also bring a different time in a historical era into the classroom. Very complicated, expensive, and unique science experimentation are also videotaped and made available to teachers and students.

Increasing Access to Education

Video and telecommunications technologies are used to increase access to educational opportunities for those who, because of lack of time or length of distance, cannot attend conventional educational institutions. Many colleges and universities offer courses to working adult learners who have only a few minutes to watch a program on television at home or cannot afford the time to commute to a campus. Institutions of higher education have also extended college courses to the place of work. Telecourses are received at the work place by employees who need new skills in a variety of areas such as management, engineering, and task–related techniques. This form of education, referred to as distance education (see section later in Part Two), is expected to increase as new technological innovations are infused to the work place.

Facilitating Educational Change

Innovations in education are recorded and shared with interested educators and colleagues in other schools and educational institutions. Transfer of innovations can be facilitated from one setting to another via video. Tiene (1986) reported on the use of video in conveying the idea of "The High School of the Future Project"to educators in the state of Ohio. His analysis of the application of video technology in transfer of innovation can be summarized in the following: Video

- adds a communication dimension that transcends what a public speaker can convey,
- portrays actual and concrete examples, and
- provides a visual survey of the project so that interested parties can judge its merits for themselves.

Thus, flexibility and immediacy of video production and distribution make video a viable medium for recording innovative ideas and conveying them to interested audiences.

Enhancing Micro–teaching

A widely practiced and successful technique in improving teaching skills of pre–service and in–service teachers is micro–teaching. To provide direct feedback to novice teachers as well as experienced teachers who wish to improve their instructional skills, a skilled observer in teaching practices and observation techniques observes the teacher trainee as he/she presents a relatively short sequence of instruction to students or other teacher trainees. After the teacher trainee completes instruction, the skilled teacher/observer provides supportive and corrective feedback to the trainee. During the feedback session, the teacher trainee is provided with specific techniques as well as general suggestions to improve instructional performance.

Since small format video systems have become widely available in schools and colleges, many educators have used a portable video system to enhance the micro–teaching technique by trying sequences in actual classrooms (Ajayi–Dopemu & Talabi, 1986; Perlberg, 1969). With video, the skilled teacher/observer can review the performance of the teacher trainee as recorded on video tape. Then both the trainer and the trainee can participate in providing constructive criticism for improving teaching performance. Self–appraisal is always more difficult while one performs; video recording of the teaching process makes appraisal of one's own performance easier for a teacher trainee.

Applications of Video Technology in Vocational Education

Most of the innovative video techniques outlined in the previous section are used by vocational technical educators as well. For example, many video programs have been produced to augment instruction for specific vocational technical competencies. These range from programs to train restaurant chefs (Rohrlick, 1979) to programs for expanding the oral hygiene curriculum in a nursing program (Briggs & Griego, 1979) to programs to initiate a competency–based welding program (Evans & Evans, 1980) to programs produced to improve basic skills of agricultural students in crop production (Campbell, 1971).

Career education and the introduction of the world of work to young learners is another recurrent theme in video programs for vocational technical education. For example, *Avenues* (1984) is a video tape series made available by the Hawaii State Department of Education to help students understand the relationships between their school curriculum and the careers they may choose, and to motivate them to plan ahead. In Pennsylvania, video tapes were used to illustrate the performance and degree of involvement of educably mentally retarded students in a school– work program (Caci, 1977). In Connecticut, Project Explore used video tapes to introduce incoming vocational technical students to occupations in sheet metal work and graphic communications (Nelson, 1977).

Another source of video programs, The AIT (Agency for Instructional Technology) Catalog of Educational Materials, lists several programs in five categories under the general heading of vocational education. The programs are categorized by type of learners (junior high school, high school, college, adult and teaching/professional development) and cover five areas in vocational education:

- career counseling,
- communication at work,
- economics,
- industrial safety, and
- jobs: seeking, finding, and keeping

There are a minimum of nine and a maximum of 16 programs available in each of these categories. Most of the programs are about 15 minutes in length.

Researchers have shown interest in learning more about the effects of micro–teaching to improve teaching effectiveness of pre–service and in–service vocational technical teachers. For example, in a project supported by the National Center for Educational Research and Development, researchers at the Ohio State University conducted a series of studies to assess the use and effectiveness of micro–teaching and video recording in vocational technical teacher education. These studies also compared the use of video with other techniques for providing feedback to teachers and teacher trainees concerning their teaching performance. These techniques were self–review, fellow teacher review, student review, and teacher– educator review. Although no statistically significant results were found among these feedback methods, the use of video in micro–teaching was recommended as a useful and effective means of improving teaching skills (Harrington & Doty, 1971; Doty & Cotrell, 1971). More recently, Peters and Moore (1980) conducted a comparative study of micro–teaching and "reflective teaching"as viable methods of teacher training in agricultural education. They found no significant difference in attitudes of learners towards the two methods of teacher training, and recommended the use of reflective teaching as well as micro–teaching for training vocational technical education teachers.

In summary, vocational technical educators have tended to use video technology in three areas:

- improving learners'skills in specific competencies related to job performance,
- introducing young students to the world of work and motivating them in career planning, and
- understanding the effects of video technology on micro–teaching as a technique in improving teaching skills.
- Potential Benefits

Video puts an immediate and flexible means of audio–visual communications at the disposal of vocational educators. It takes money and time to obtain the necessary equipment and master their operation, but once the front capital in equipment and training is invested, it's possible to use the technology in its various conventional forms or devise individual innovations. For example, a video camera and a large monitor can be used as an electronic blackboard to enlarge and amplify charts, graphs, texts, and equipment demonstrations during classroom instruction.

Cartwright (1986) has outlined the potential benefits of video technology for training in the corporate setting. These benefits, however, are not limited to the private sector but hold true in public education as well:

Video technology saves time. Many routine instructional sequences can be videotaped to save time for the instructor and the learner. The instructor can use the time spent in delivery of repetitive instruction for more creative endeavors, and learners can watch these segments when they are free to do so.

Video technology saves money. Once the front capital has been invested in the technology and related training, video can save money by reducing costs of expensive equipment demonstrations, laboratory experiments, field trips, and delivery of repetitive instruction. Although the technology is not meant to replace real experience, it can be beneficial when the real experience is not at the disposal of the instructor, or in cases where the vicarious simulated experience via video is more efficient, cost effective, or safer.

Video technology provides consistent training. Video taped instruction is consistent and reliable. A VCR does not get tired of repeating recorded messages or forget to relay facts and step–by–step procedures. These routine teaching and learning tasks can be achieved with consistency and reliability by pre–recorded video segments that are tested for their accuracy. In this age of information explosion, such reliable systems free up time that instructors and learners need to spend on more creative problem solving tasks.

In addition, video technology can be integrated with other technologies to form the integrated communication environment of the future. This integration has already begun between computers and video systems in interactive video and in integrated telecommunications systems (Gooler, 1986). Several features have made video technology a unique and a universal means of communications: its flexibility and immediacy; its connectivity and adaptability to computer technology; its capability to display text, graphics, still and moving images; its capability to present a full range of audio signals with high fidelity and in multiple tracks (e.g., stereo

sound); and its capability to be presented through airwaves as well as through wired media (e.g., cable and fiber optics). These features in video surpass the limitations of other forms of communication technologies such as print and film. The marriage of video and the computer (a marriage that is technically impossible between the computer and other media such as print and film) has created Hypermedia (Young, 1986), the integrated communications environment of the future. In this environment video, computers and telecommunications are joined to provide the means for storing, classifying, using, and comprehending the explosive amount of technical and scientific information that has characterized the dawning of the New Age in post–industrial societies. In this era video literacy and computer literacy are equally important since, together, they define how we communicate, learn, and teach.

Video Equipment

To introduce you to video production equipment, components of a simple video system will be described and analyzed, since most educators and trainers will find this combination more suitable to their needs. In addition, video editing (or post–production) will also be described and analyzed to show how users of a simple video system can produce relatively sophisticated instructional and training programs by editing their tapes. Studio video production will not be described, as the costs of this more involved form of video production is prohibitive for most single school or school districts.

A Simple Video System

In its simplest configuration, a video system consists of the following components:

- camera
- tripod and a dolly
- recorder
- video monitor
- microphone
- pair of earphones

The function of a video camera is to change the light captured by its lense to an electric signal. The camera lense focuses the light and dark parts of an image on a photosensitive plate or an imaging device (e.g., a picture tube). The photosensitive plate emits electrons in proportion to the amount of light hitting its surface. An electron gun scans the surface of the plate and shoots off the remaining electrons from the plate's surface. The electrons are collected, turned into a signal and sent to the monitor and the recorder.

In the monitor, the same process is repeated in reverse. The electron gun scans the surface of the picture tube. The picture tube's surface is treated with phosphorous; when it receives electrons, it glows in proportion to the amount of electrons received and a picture is formed on the screen. In the recorder, the electric signal from the camera is received at two video heads (some VCRs are equipped with four video heads for longer play time and special effects) which create a magnetic field. This magnetic field rearranges the tiny particles of iron oxide on the surface of the tape, thus recording the image on its surface. When the tape is played back, the video heads read the tape and emit a signal which travels to the monitor for viewing.

The function of the microphone is to change sound waves into an electric signal. There is a plate (or a similar component) inside most microphones that vibrates as it is hit by sound waves. The plate's vibration changes the magnetic field of an electric circuit surrounding it. This signal is passed through the microphone cable to the video recorder and is recorded on the audio track of the video tape and/or is sent to the speaker of the monitor.

The audio and video processes are oversimplified here to provide a basic understanding of how they work. Grob (1984) presents a more technical description of video and audio technology. Video cameras, tripods, recorders, microphones, and monitors come in different formats. Although their functions are similar, formats and prices are different; these are reviewed below. Additional information regarding available formats and prices of equipment may be found at local equipment dealers. Dealers are listed in the yellow pages of the telephone directory. Subscriptions to video journals can help keep vocational educators aware of changes in technology, new models in video equipment, and prices.

Two journals with free subscriptions for educational and business establishments are:

AV Video, Montage Publishing, Inc.
25550 Hawthorne Blvd.
Suite 314,
Torrance, CA 90505

Video Systems
PO Box 12901
Overland Park, KS 66212–9981

More complex video systems/components include:

1. Video Cameras can be classified by the size and type of imaging device, the quality of image, and price. Another useful method of categorization is by application, which subsumes the other classifications:
   - Broadcast quality cameras produce a high quality color video image. They have three pick–up tubes for the three primary colors (red, blue and green) and range in price from $7,000 to $100,000. These cameras are used for a variety of production purposes in the broadcast industry. Portable models (smaller and often lower in price) are used for news gathering and documentary production. More expensive and larger cameras are used for studio production and telecast of dramas, games, variety shows, news, and educational programs.
   - Industrial quality cameras produce a good quality color video image that may not be acceptable for broadcast purposes, but is adequate for the majority of instructional, training, and corporate communication video productions. These cameras may have three tubes, in which case their price ranges from $3,000 to $8,000, or they may have a single tube with a price range of $1,200 to $3,000.
   - Home quality cameras very often have only a single tube and cost under a thousand dollars. Their color image is adequate for making home movies but does not have the resolutions required for the production of good quality instructional and training programs.

Over the past thirty years, video camera technology has remained basically the same. Different techniques have been used for image reproduction in the pick–up tube and the printed circuits, and semiconductors have been used to make smaller and less expensive cameras. However, the basic design of video cameras remained the same; a pick up tube was used for image reproduction. Recently, there has been a significant change in the basic design of video cameras. New cameras do not use a pick up tube for image reproduction. This function is carried out by a new device called a charged coupled device (CCD). The function of the CCD is the same as a pick up tube; it changes light to an electric signal. However, the CCD uses a new technique which provides a more stable and sharper video image, is more durable, and has led to the production of much smaller and less expensive cameras.

2. Video Recorders are often classified according to the width of the tape they take and the technique they use for recording and playback, hence, 1/2 inch VHS (Video Home System), 1 inch C format, Betamax, etc. Programs recorded in each format can be played back only on the same format, therefore 1/2 inch VHS is not compatible with Betamax or 1 inch C format.
   - 1 inch C format recorders are very expensive ($10,000 to $50,000) and are primarily used by broadcasters who have to adhere to technical standards set for them by the Federal Communications Commission (FCC). This format is useful to educators and trainers only if they wish to produce a program for broadcast or for transferring a program to a video disc.
   - 3/4 inch U has emerged as the most widely used video cassette recording format in business and education. Many public schools and institutions of higher education use this format for production and distribution of their programs. The price of recording equipment in this format ranges between $3,000 to $5,000. The price of tape for this format is about $50 for an hour of recording. These recorders use only one speed. Used with a broadcast quality camera, they reproduce an acceptable image for broadcast purposes; they also come in light models for field production.

- VHS and Betamax recorders are less expensive ($300 to $3,000) and lighter than 3/4"U format, but they cannot reproduce an image as sharp and as stable as the 3/4"U recorders. Nevertheless, they have found many users in corporate communication departments, schools, and universities. At the outset, Betamax was manufactured only by Sony and its popularity did not increase as much as the VHS format. All other manufacturers make VHS recorders, which have rapidly gained the number two position in popularity after 3/4"U among video users. Beta and VHS cassette tapes are also much less expensive than 3/4"U cassettes ($6), and they can be recorded in three speeds, therefore providing longer recording and playback time. Standard play (SP) speed, however is recommended for professional use. This speed on a VHS tape will provide 2 hours of recording time (1 hour for Beta).

A relatively new development in video technology is the production of camcorders by virtually all equipment manufacturers. This equipment is a combination of a video camera and a video cassette recorder attached together. This innovation makes the video production process a little easier, since the camera operator does not have to connect the camera to the recorder by at least one (and at times several) cables each time. Camcorders are light, durable and depending on the quality of their imaging device (many models use a CCD), they can produce acceptable images for educational, training, and business/industrial purposes.

3. Video monitors are most often classified by the size of their screen (e.g., 10", 13", 26"). Generally, the bigger the size of the screen, the higher the price. They range in price from several hundred dollars to more than a thousand dollars. Video monitors can reproduce the image they receive either directly from a camera or from a video tape recorder. Some monitors do not have a speaker so they cannot reproduce sound. Monitors are used in small format productions for previewing a take as it is being recorded, or after it is recorded. Video monitors do not have a tuner and, therefore, are incapable of receiving a radio frequency signal. In other words, you cannot watch your favorite television programs on them. Receiver/monitors, however, have a tuner and enable you to use them for viewing broadcast television programs, viewing images, and listening to sounds from a video tape recorder or live images and sounds from a camera or a microphone.

4. Microphones come in a variety of shapes and forms and range in price from a few dollars to a few hundred dollars. They are classified by the way they pick up sounds from their surroundings. For example, a uni–directional microphone picks up sound only from the direction at which it is pointed, whereas an omini–directional microphone picks up sound from all directions. They are also classified by the way they produce their signals, such as dynamic, condenser, or crystal. Dynamic microphones have a very good frequency response (they pick a wide range of audio frequencies) and are used by many producers for voice and music. They require no internal or external source of power and are easy to use and store. They range from $50 to $200 in price.

Condenser microphones are also popular among professional video producers. They have an excellent frequency response and are used for recording voice and music. These microphones range in price from $25 to $600. They need either an external or an internal (a battery) source of power. A very useful condenser microphone is called the lavalier, or tie tack. It is very small, can be placed on a lapel or a tie, or can be easily concealed. It has a very good frequency response and is relatively inexpensive. Video producers often use a highly directional microphone or a shot–gun microphone which picks up sound from afar. This is a desirable microphone for scenes in which the producer does not wish to see a microphone in the image that is recorded.

Crystal microphones are relatively inexpensive ($5 to $25) and do not respond to the range of frequencies as well as dynamic and condenser microphones. They reproduce a high frequency audio signal and are more suitable for voice recording. This type of microphone is rarely used by professional

video producers.

Microphones can be put on a variety of stands (short stands on table– top and higher stands for stand–up presentations or music recording). They can also be put on a movable stand called a boom so the audio person can follow the source of sound during a recording session.

5. Tripods are used to support the camera during shooting. They may be placed on a three–wheeled base called a dolly so the cameraperson can easily maneuver the tripod. The camera is placed on the head of a tripod. There are a variety of heads available in the market, and depending on their mechanism, they can be very expensive. Fluid heads provide the best support for the camera; a camera can easily be balanced on a fluid head and the cameraperson can pan or tilt it smoothly. Other types of heads such as the cradle head or a simple friction head are less expensive but also provide less control. Selecting a tripod and a dolly is not an inexpensive proposition; depending on the material used in its construction and the type of head and dolly, one can spend about $1,000 on a tripod, dolly, and head combination.

Production equipment outlined and briefly described here allow educators and trainers to record video segments or to use the equipment for other purposes such as microteaching, researching, or recording work sequences. This production equipment, however, will not permit editing a program, rearranging the recorded sequences, adding titles, credits and other graphics, or adding narration (voice–over) or music after the shooting is completed. Performing these functions requires editing equipment. Complemented with a video switcher, a microcomputer, an audio mixer, and audio playback units such as a compact disc player, video editing equipment will allow vocational educators to edit tapes and create good quality complex video programs.

Video Editing (Post–Production) Equipment

Video editing equipment is comprised in its simplest form of a playback unit (source deck), a recorder (editor deck), an edit control unit and two video monitors. While editing you select a recorded segment on your video tape (source tape), and literally duplicate that segment on a blank tape (soon to become your edited master). The edit control unit permits selecting precise points on the source and edited master tape, and transferring audio and video segments from the source tape to the edited master tape without a glitch between two shots. This process is also called post–production. Simple editing systems for 3/4"U format cost between $10,000 to $15,000. The cost of editing equipment is much lower for VHS or Beta equipment; in these formats an editing system can be purchased from $6,000 to $10,000.

A simple editing system can be gradually augmented with additional equipment to provide more flexibility to post–production processes. For example, with the addition of a video switcher, other video sources such as a microcomputer or a video camera can also be fed into the editor deck. This enables the editor to use graphics generated in a microcomputer for titles, credits, and other purposes. Most microcomputers, however, do not produce a compatible signal with the standard video signal. Therefore, their output should be processed through an adaptive card that is often called a NTSC (National Television Standard Committee) card. These cards are available for most microcomputers and cost between $1,000 to $3,000. Through a switcher, a video camera can also feed additional video segments, such as the image of a conventional graphic, the image of a three dimensional model of an object, or even a live announcer to the editor deck. With the use of a switcher, the editor can mix several video sources, create special effects and produce a fairly complex and sophisticated video program. To further develop the post–production facility, a time–base–corrector (TBC) can also be added to the system. The function of a TBC is to synchronize the various video sources fed into the switch. TBCs can stabilize the video output of source decks and solve many post–production problems. However, they are expensive; Prices of a TBCs range from $8,000 to $20,000.

To add music or a voice–over narration to an edited master, an audio mixer, a microphone, and at least one audio playback unit (e.g., a compact disc player) can be added to the post production facility. Another way of adding sound to an edited master tape is to take the tape to an audio studio equipped with a

video recorder and add the desired audio segments on it. Many local video dealers rent post–production facilities and audio studios.

For more information on editing, see:
Anderson, G. H. (1984). Video editing and post–production: A professional guide. White Plains, NY: Knowledge Industry Publications.

Video Distribution

A variety of electronic and non–electronic means are used to distribute video programs to millions of people for entertainment and learning. For example, over the past five years, a new service industry has emerged to rent video tapes; practically every neighborhood in most urban areas and many rural areas have at least one video store. The low cost of video cassette players is a major factor in the popularity of video rental stores. Players for playback and off–air recording purposes cost between $200 to $600. This cost factor, the practicality of recording, and the possibility of immediate playback have made video a universal means of audio visual communication.

Non–electronic Distribution Systems. Video programs produced for educational and training purposes are distributed through:

- film libraries based in institutions of higher education,
- a national organization called Instructional Television Agency (ITA), and
- commercial publishers and distributors.

These distribution systems are described in a bit more detail below.

1. Film libraries have been established in several institutions of higher education in which a collection of films and video tapes for regional distribution are stored. These libraries publish annual catalogues listing their films and video tapes. The title of each video is followed by a short description of the content of the program. Many of these regional film libraries serve not only their home campuses but also the public schools and other educational institutions in their vicinity. Public school teachers, administrators, and librarians, as well as college professors and other educators, can receive video programs from these libraries. Video tapes are shipped to clients either through the mail or through commercial carriers. The cost of rentals is reasonable and in most cases includes shipping, handling, and insurance.

2. Agency for Instructional Technology (AIT) distributes video tapes, films, computer programs, and related printed materials to schools in the U.S. and in Canada. A brochure of AIT describes the origin, goal, and function of the organization as follows:
Evolving from a television library begun in 1962, the nonprofit American–Canadian Agency for Instructional Technology was established in 1973 to strengthen education through technology. AIT pursues its mission through the development and distribution of video, computer programs and printed materials in association with state and provincial education agencies. In addition, AIT acquires, enhances, and distributes programs produced by others. AIT programs are used in schools throughout the United States and Canada. The agency is based in Bloomington, Indiana.
AIT publishes an annual catalog in which its programs are listed and described. Prices and conditions for renting and using programs are also described in detail. The agency publishes a quarterly newsletter which contains the latest information on its activities and new acquisitions. [NOTE: See Chapter 3 for the address and telephone number of AIT.]

3. Commercial publishers and distributors also produce and distribute instructional video programs. Their collection is listed and described in catalogs that are published annually.

4. Video stores have formed a natural system of video tape distribution as the result of a market demand for entertaining motion pictures. These stores usually cater to the entertainment needs of their clients; many, however, have also begun to circulate video tapes with popular instructional content. For example, how–to video tapes on a variety of subjects, ranging from how to keep physically fit to how to grow vegetables in your home garden, have been gradually added to the col-

lection of tapes in these stores. Nevertheless, instructional programs constitute a very small percentage of their total collection, and this efficient distribution system has remained to be discovered by the producers and distributors of educational and training programs.

Electronic Distribution Systems. Video programs can also be distributed over telecommunications systems. These systems range from broadcast television to more recently developed technologies such as communication satellites, cable television, and fiber optics. These technologies are described below:

1. Broadcast television is the oldest and the most common means of video distribution. The Federal Communications Commission has allocated a certain band of frequencies for the transmission of television programs in each local area. Local television programs are transmitted over Very High Frequency (VHF, 30 to 300 MHz) and Ultra High Frequency (UHF, 300 MGz to 3 GHz) channels. Channels 2 to 13 on the VHF band and 14 to 83 on the UHF band bring local television broadcasts to television sets in homes. The range of local television broadcasts is about 75 miles; weaker images and sound signals occur as the distance is increased from the television transmission antenna. VHF and UHF television signals are also fragile; they cannot pass through barriers such as tall buildings and hills. Broadcasters use other transmission technologies to overcome distance, physical barriers, and channel capacity limitations.

2. Microwave transmission is used by broadcasters to relay network programs from coast–to–coast or from one city location to another to overcome distance and physical barriers. The frequency range of microwave transmission is between 1,000 MGz to 50 GHz. In these high frequencies, electromagnetic waves travel farther and carry many more channels. Considering the fact that the FCC has assigned 6 MGz of band width for each television station (10,000 Hz for each radio station), microwave transmissions can carry many radio and television programs simultaneously.

In many local areas, the FCC has allocated specific microwave channels to instructional use. These broadcast stations, known as the Instructional Television Fixed Service (ITFS), operate from a variety of institutions such as county offices of education or college campuses and provide instructional programs to students in schools or adult learners in industrial and business sites.

3. Communication satellites were developed to provide wider geographic coverage as well as more channel capacity to broadcasters. These satellites, placed at 22,300 miles above the equator, rotate at a speed which makes them synchronous to earth's orbit; therefore, they remain stationary in relation to earth. Communication satellites operate on Super High Frequency (SHF, 3–30 GHz), providing more channel capacity to broadcasters than previously mentioned modes of transmission. From several thousand miles above the earth, they also cover a wide geographic area and have a vast footprint.

4. Cable television, first developed to extend broadcast television services to urban and rural areas which could not receive such broadcasts, has grown to extend many other sources of programming to home users. Cable television uses a coaxial cable to distribute video and the associated audio signal to its users. Cable casters receive a variety of programs from on–air local broadcasts and satellite transmissions from different parts of the country. They amplify these signals and distribute them from their office (head–end) through a network of coaxial cables to the end user at home. In some communities, the cable is placed under ground, in others on utility poles. Cablecasters carry the programs of local broadcast television stations, but since they have many more channels available to them (more than 100 channels in many communities) they also carry programs that are beamed to the satellites by broadcasters from other parts of the country. For example, many cable companies across the country carry programs from the Atlanta–based local television station WTBS. Several new forms

of programming via the satellite have been developed to fill the channel capacity of local cable networks. For example, Cable News Network (CNN), an all news station, and Entertainment and Sport Network (ESPN), an all sports station, present their programs to their audience via the satellite and the cable television systems.

In all communities, either the state utility commission or city hall regulates the activity of cablecasters. Local regulators in many communities have required cable companies to allocate certain channels for educational broadcasts and public access. Educators and community organizations may use these channels for educational programs, community forums, debates, or other varieties of programming in the public interest. Many cable companies provide small format video systems, small production studies, or remote trucks (vans equipped with video production facilities) to educators and community organizations to produce such programs. Many cablecasters also distribute programs produced in video facilities of schools, colleges, and universities through local cable systems.

Cable television systems can be designed and constructed to provide two–way communication between the user and the head–end. This feature of cable television can be very useful in educational programming to provide direct two–way communications between the instructor and students. However, the two–way capability of cable television has not been used nearly as much as this technology theoretically can offer.

5. New developments in telecommunications. Telecommunication engineers in search of more channel capacity have developed a new technology that uses tiny strings of glass or plastic to transmit video, voice, and data. These strings, known as optic fibers, carry light waves (monochromatic laser light beams) with Extreme High Frequency (EHF, 30–300 GHz), therefore offering almost unlimited channel capacity. So far, fiber optic cables have been used for lines between two cities or for very long lines for coast–to–coast communications. One reason for this is that glass fibers are no thicker than 100 microns (.01 millimeter) and it is very difficult to splice them with precision. Therefore, they have been more useful for the construction of long distance trunklines than for short distance networks. With the development of new splicing techniques and the advent of new materials such as plastic fibers, the wider use of fiber optic telecommunications is certain to become a reality within the next five years.

Implementation of Video Technology

Some vocational educators may wish to produce their own programs. This section is devoted to an overview of the video production and utilization process. Although this is a comprehensive overview, it lacks great detail; a more complete coverage of the competencies and information needed to produce video programs is impossible in this chapter. Zettl's *Television Production Handbook* (1984) is written for those who wish to gain a thorough, comprehensive, and detailed knowledge of video production techniques and procedures. This classic text, however, tends to emphasize full scale studio–based multi–camera video production. In his excellent text book *Today's Video*, Utz (1987) puts emphasis on techniques and procedures of small format video production. *Today's Video* is an excellent reference for the beginner, the intermediate, and the experienced professional in video production.

Whether the choice is to produce a full–scale program or engage students in a small format video production, the basic phases of video production are the same:

- pre–production planning,
- production,
- post–production, and
- evaluation.

When showing a self–produced or pre–recorded program to a class, certain steps are necessary to ensure optimum student learning. In this section, the production and utilization process is described.

The Production Process

1. Pre–production planning. Pre–production planning is vitally important; without it, success will be limited. The more time and effort exerted in this phase, the greater the chances for success. Steps include:

A. Access students'needs. Like other media production procedures, video production starts with assessing the learning needs of students. Learning needs are assessed by measuring (as is) the performance of students in a particular skill area and comparing that base line performance with what ought to be. Rossett (1987) described performance needs assessment as subtracting actual performance of learners from an optimal performance. She provided detailed techniques for assessing training needs in organization and schools.

For a thorough review of the concepts and techniques of needs assessment, see:
*Rossett, A. (1987). **Training needs assessment.** Englewood Cliffs, NJ: Educational Technology Publications.*

B. Determine performance objectives. Once the performance needs of students have been determined, and those needs have been attributed to lack of training as distinguished from other causes of inadequate performance (such as lack of equipment to perform a certain task), then performance objectives may be defined for learners. Mager (1984) provided specific techniques for defining instructional (performance) objectives. As he emphasized, defining instructional objectives is an important component of instruction and training. He has reminded trainers and educators many times: if you don't know where you are going, you may not get there!

For a detailed review of concepts and techniques related to defining instructional objectives, see:
*Mager, R. F. (1984). **Preparing instructional objectives.** Belmont, CA: Davide S. Lake Publishers.*

C. Outline content of program. Assessing performance needs, in addition to enabling you to define objectives, will also provide a clear idea of what students should know in order to perform certain tasks. What they do not know or cannot perform should determine the content of a program. It is a good idea to outline these areas of information (knowledge) or performance at this stage before proceeding to pre–production planning.

D. Develop treatment. Before writing a script, another step should be taken: determine the appropriate style for treating the content of the program in your script. The style determines a variety of elements which are important in how a script is written, how the program is produced, how much money will be spent on the program, whether actors will be hired, special graphics produced, certain props obtained (e.g., equipment) and other such considerations as required by the subject of your program. The treatment, as important as it sounds, is usually written in one or two paragraphs and starts with a sentence such as: The style of this program will be dramatic (meaning actors will dramatically depict the content) or documentary (meaning you will shoot an actual event on location). For more information on writing a treatment see Zettle (1984).

E. Write production script. Once the style of a program is determined, specifications may be made to determine which images and sounds must be recorded and edited in order to cover the content of the program. A script should contain this information. It is usually written shot by shot in two vertical columns, one for video and the other for audio. The video column describes the shot to be framed by the camera, and the audio column contains the narration, dialog, or music related to each shot.

Screen writing is an art and, like other forms of writing, can be mastered by practice. To get started, you should read:
*Blacker, I. R. (1986). **The elements of screenwriting: A guide for film and television writers.** New York, NY: Macmillan.*

When writing a script, principles of instructional message design are important. These principles should be taken into consideration when writing each shot, when relating shots together in a sequence, and when relating sequences together to create a whole script.

For a review and discussion of these principles, see:

*Fleming, M. & Levie, W. H. (1978). **Instructional message design: Principles from the behavioral sciences.** Englewood Cliffs, NJ: Educational Technology Publications.*

F. Develop production budget and schedule. Before commencing production, it is a good idea to develop a detailed production budget. A typical production budget should include expenditures for personnel (writer, director, camera operator, audio technician); equipment rental or purchase (camera recorder, microphone, lighting instrument, monitor); expendable materials (video tape, computer disc, paper, etc.); props (e.g., laboratory equipment); and services (which normally includes travel, lodging and food for the cast and the crew). If you have the equipment at your school and recruit your talent and crew among your students, your production cost should be limited to expendable materials such as video tape, batteries, and props. Assuming that you will videotape on campus and do not need to travel, your production costs for a 15–minute program should stay under a hundred dollars. If you have to rent equipment, shoot on location away from campus, and pay people to act, your cost will increase from several hundred to several thousand dollars. Experience shows that such in–house productions with rented equipment for a 15–minute program could cost anywhere from $2,000 to $5,000. This still is a reasonable cost compared to what a professional video production company might charge you for the same project. Industry rates vary among production companies; however, the cost of one minute of finished product ranges from $2,000 to $5,000. Yes, it pays to learn how to operate the equipment and recruit your students to be the talent! The largest amount of expenditure in professional video production is on the talent and the production crew.

In order to form a realistic view of the time required to produce a program, you also should allocate time intervals for each step in the pre–production, production, and post–production processes. As you develop a production schedule, you will notice that the production process is not as linear as may be implied in this step–by–step description. Several tasks can be, and ought to be, undertaken simultaneously. Normally, if you are good at operating equipment, and have rehearsed the script with your cast and crew, it should take two to three days to shoot a 15–minute video program. Editing and post–production of the program, however, may take two to three weeks.

2. Production. This phase involves recording video and audio segments according to script and in the style specified in treatment. Activities in this phase include:

- hiring or recruiting production personnel,
- hiring or recruiting actors,
- selecting shooting location(s) or a studio,
- visiting site of shooting or studio (site visit),
- obtaining legal releases from those who will appear in program but are not paid,
- recording audio and video on location, or in studio,
- reviewing the rushes, and
- re–recording needed segments.

3. Post–production. In this phase, video and audio segments are edited according to script. Post–production may require recording of additional video and audio segments, dubbing music and sound effects, and creating and editing graphics. This phase usually includes:

- developing a post–production strategy to decide how you will approach the entire editing process;
- logging the recorded footage;
- reviewing and selecting needed footage;
- selecting and recording music;
- selecting and recording sound effects;
- obtaining legal release from the owner(s) of pre–recorded music;
- selecting narrator and recording narration;
- selecting, developing, and recording graphics—including titles, credits, charts, figures, tables, and still shots such as

photographs, slides, and pictures from magazines;
- editing video footage, graphics, narration, music, and sound effects;
- reviewing edited master for accuracy of content, technical errors, and aesthetic judgment;
- subjecting the edited master to formative evaluation; and
- correcting errors.

These tasks are professional and technical in nature, but they may be mastered if you start with simple productions and gradually increase their complexity. Many community colleges and universities offer formal courses in video production. Taking a course in video production can greatly assist you in getting started. Zettle (1984) and Utz (1987) also provide valuable guides for beginning video production and improving your skills.

4. Evaluation. The most significant element in producing a video, as in all other instructional media production, is for the learner to reach a level of performance specified in the instructional objectives after previewing the video. Materials should be evaluated as the production process progresses to ensure that the video is designed and produced for its stated purpose. For example, once a draft of the script is created, you should read certain segments of it to a small sample of the intended audience and see how they react. Are they comfortable with the vocabulary of narration? Is the level of difficulty in presenting facts, concepts, rules, and behaviors easy for learners to understand? Are there enough examples for each concept? Other questions may be asked regarding production values: Is the music selected for the program suitable for the audience? Does the music interfere with the narration? As production progresses and certain video segments are recorded, these segments may be shown to a small sample of audience to collect more formal data on its effectiveness. If the segments are effective and learners reach specified objectives, the production may be continued with more confidence. If not, segments that are not working should be modified. This evaluation process conducted during the formative stages of the production process is appropriately called formative evaluation.

As a video producer, you also should be concerned about the effectiveness of your product after the production process is completed and the product is put to use. To collect data on the effectiveness of your program, you can measure the knowledge and performance level of your audience before viewing the program (pre–test), show them the product, and test their level of understanding and performance after they have watched the video (post test). This summative evaluation should collect at least three types of information:

- demographic data on the audience (e.g., sex, level of education, socio–economic status, etc.);
- changes in overt behavior indicating comprehension and/or change in level of performance;
- production values (e.g., clarity of visuals and audio, appropriateness of music, legibility of text, etc.).

Testing and evaluation is a highly technical function. You might wish to consult an evaluation specialist to select a strategy and develop reliable procedures and instruments.

The Utilization Process

Students and the classroom condition both need preparation prior to showing a video program. Also, certain post–viewing activities help students comprehend material better and retain it longer. In the following, a utilization process before and after showing a video program is listed. By following these steps, you can avoid unnecessary problems that could occur with media in class and improve learning conditions for students.

Always preview the video program before showing it to students. This is to avoid surprises as far as physical conditions and the content of the tape. If the tape is broken or damaged, it is better to find out before the class rather than during the showing of the tape. If the tape contains objectionable materials or incorrect information, make a list of these items so you can discuss them with students before presenting the program.

- List important segments of the video. This is to help you lead a discussion before and after showing the video program.
- Examine printed materials accompanying the video program. Examine instructional objectives of the program and relate them to other objectives you have listed for that class period.

- Duplicate handouts, tests, and other materials for students. Do not violate copyright conditions of materials. If the test instruments are copy protected, prepare your own test instrument for pre–testing and post testing students.
- Develop a set of questions as discussion starters. This engages students in discussing content of the program after they have seen the video.
- Examine the equipment an hour in advance of your class meeting. Make sure the VCR, monitor and cables are in working condition. A good practice is to recruit a student (each time) to be your assistant in setting up, checking, and storing equipment.
- Check lighting in class. The room does not need to be darkened for showing a video tape. However, the position of the monitor should be examined to restrict glare on it from windows and artificial sources of light. If there is excessive light, turn off the bank of lights or close curtains near the monitor.
- Check the position of monitor to make sure that all students can see and hear well. Students should not sit closer than twice the width of the image and no further than six to eight times the width of image from the monitor. Two monitors are advised if more than 20 students are in the class. An external speaker, in addition to the one in the monitor, can amplify the audio for a large group of students.
- Pre–test students to collect base line data on their competencies before they preview the program.
- Provide an overview of the video program before showing it to students. Specify the instructional objectives and clarify what they should learn from the program. Relate content of the program to their reading assignment, classroom activities, homework, and other learning activities. Point out the important segments in the program and discuss its inaccuracies or biases.
- Review the program after you have shown it to the class. Engage students in a discussion of important points covered in the program. This post–viewing discussion and feedback helps clarify learning materials and increase retention.
- Post–test students to collect data on learning after showing the program. You may wish to give them another test later to see how much information they retained.
- Examine the equipment after using it; make a list of defects and problems you have encountered with the equipment. Inform the media technician or the administrator in charge of the problems.
- Store equipment properly. Avoid temptations to leave equipment in class—return it promptly to a storage area. This is to lengthen the life–time of equipment; they may look sturdy, but most modern VCRs, monitors and cameras have delicate parts that may be damaged if not handled carefully.

For more information on utilizing video and other media, see:

Simonson, M. R., & Volker, R. P. (1984). Media planning and production. Columbus, OH: Charles Merill.

CHAPTER 5

Microcomputers

A Scenario

Carol Johnson has recently become chairperson of the Business Education and Marketing program at West High School. She left a good teaching job for the position and was afraid of sacrificing interesting work in the classroom for a job with tedious paperwork, but her fears were unfounded.

She expected access to computers and administrative support in her new position, but she was uncertain regarding the use of those computers. She assumed, however, that she could use the computer to complete her paperwork in a timely fashion, and that she could use the computer as an instructional tool to redesign what many had referred to as a tired and outdated curriculum.

To begin, Carol wanted to change the Office Occupations curriculum so that it contained competencies students would need for jobs in the local community. To achieve this end, she created a Model Office Simulation Program. The focus of the curriculum was acquainting students with the business world and using technology in the office. Previously, the only available course on this topic was Computer Programming. The new course was designed so that the classroom simulated an office. The class was set up in stations. Several computers were available at the stations as work tools, and one computer monitored students' progress through the various stations.

For example, at one station students learned how to use word processing software. A tutorial guided them through the program. In order to progress to the next station, they needed to complete numerous assignments using the software. At another station, mailing lists needed to be completed and organized with a database management system. The students also had an opportunity to learn how to use spreadsheets. Workers who verified task lists for the office occupations program cited spreadsheets as the current means for completing monthly payrolls for their companies.

The new course is not a beginner's course but is a requirement for any student majoring in Business Education. It provides the kind of experience that not only presents creative challenges to work ex-

This chapter was prepared by Dr. Judy Rodenstein, a researcher with the Vocational Studies Center, University of Wisconsin–Madison.

periences but exposes students to the role of the computer in the office.

Carol uses her computer to monitor student movement through the model office stations, to enter grades, and complete final reports. She entered the guides and assignments for each station on the computer so they could be easily updated as the technology improves.

As she developed it, Carol's role as administrator changed, and so did the teacher's. Teacher instruction time in the new course was minimal. Instead, the teacher took on the role of supervisor in the same way a supervisor would work on the job.

Local employers stated they wanted applicants to possess mastery of certain skills. The computer was used to prepare a career passport which contained a list of competencies mastered at each work station and a description of the work assignments completed.

Carol discovered numerous ways that the computer could help her and the teachers she supervised. The computer has the capacity to generate test items in a variety of subjects so that the student's ability can be assessed by the student and the teacher. A summary of the student's competencies can then be presented to a possible employer at an interview. The computer can also be used to produce classroom study exams so students can use the computer to independently prepare for an exam. Carol employed one of the office staff to enter over 2,000 multiple choice questions into the computer. Each was coded by a number which identifies job tasks covered by the question. If teachers want to generate an exam, they select the objectives and designate the number of questions needed for each objective. The computer selects the questions at random and prints the exam. After the test has been completed, the computer grades the answer sheets. The scores are automatically recorded by the computer. In addition, the computer analyzes the test results, providing the instructor with valuable statistical information includes an item analysis.

Carol had hesitated to take an administrative job in vocational education because she feared that it would take her away from what she liked to do best: teach others how to use their abilities to the fullest. Instead, the computer has led her into a whole new world of education enhanced by applied technology. It allows her to teach and learn in ways that could never happen in a traditional classroom.

The Growth of Microcomputer Applications in Education

The microcomputer was first adapted for educational purposes during the fourth generation of computers in the early 1970s. This occurred because the silicon chip was developed. These microchips revolutionized computing, becoming the foundation for building memory boards, input devices, and output devices. The resulting units were called microcomputers. The microchip was not only transforming educators' access to the personal computer industry, but the same microcomputers were also appearing in equipment that had never been computer-based, such as medical equipment, automobiles, terminals at airport reservation counters, and industrial equipment.

Use in schools was restricted because the memory in the first microcomputers was small. The computer was still used primarily in traditional computer-oriented curricula such as computer science and math. Educators began to hear more about this technology and how it could move us beyond instructional methodologies that depended on chalkboards, slides, overhead projectors, and films. Interest in educational applications of microcomputers began to increase.

With the ensuing advances in microelectronics, a more affordable microcomputer became available to educators. These microcomputers had expanded memory and could accommodate software and hardware that did not demand expertise in programming. Vendors began to view the educational community as an untapped market and began to direct resources toward developing software and hardware for the educational community. Software was expected to incorporate theories of teaching and learning that were used in the classroom. Educators were hired to develop software and interweave learning theories, curriculum content, and computer technology. Eventually, microcomputers became more widely used as a tool for instruction and administration in schools.

The impact of the technology on education may be only the beginning. In the future, microcomputer technology will be used in artificial intelligence

machines which may mimic the expertise of human specialists in almost any field merely by teaching the computer a large collection of simple rules. The technology will be used to automate libraries, run interactive video machines (which build on the strengths of the computer and the communicative power of television), and simulate work environments and job tasks that were previously unavailable in the classroom.

Vocational educators will use the microcomputer in many of the same ways as general educators, but vocational educators have specific and unique needs which require additional uses of microcomputer technology. The concern with job related skills and the predominance of competency– based education will influence how microcomputers are used in vocational education. The microcomputer will not only change the way vocational educators teach, but also what they teach.

This chapter briefly introduces the technology used in the microcomputer and explains how the technology has been used to deliver vocational education.

Components of a Microcomputer

Similarities and differences exist among types of computers. All computers are data–handling machines that store, compare, and manipulate information. Computers differ in size and power. The largest computers are referred to as mainframe computers. Years ago, this was the only kind of computer that existed. These computers are physically large and incorporate the capability to perform applications requiring large amounts of data. The minicomputer is smaller than a mainframe but larger than a microcomputer. The microcomputer is a small, self–contained computer whose mainframe is made of highly compacted integrated circuitry. The computer system is made up of hardware and software.

Hardware

All computer hardware systems are collections of devices that include four components which work together to complete a job. They are:

1. **The central processing unit (CPU).** Every microcomputer has a processor which is the brain of the computer. It reads instructions, manipulates, moves, and/or analyzes information. The CPU can vary in its level of sophistication and power.
2. **The input device.** This is the link between the user and computer. It takes information entered by the user and carriers it to the memory of the computer. Input devices might include the keyboard, a mouse, floppy disk, punched cards, or a modem.
3. **The memory.** The memory is where information is stored. This information consists of programmed instructions which are coded in a language that the computer can understand and process. The amount of information and instructions the computer can store depends on the size of the main memory. The memory of every computer needs to hold three things at one time: essential operational instructions, a program, and information/data entered by the user such as letters, mailing lists, or test scores.
4. Output devices. Output involves the process of moving data from the internal memory of the computer to a presentation device that shows information to the user through a printer or video screen.

Software

Computers perform selected functions by following the instructions contained in a program. A program is also commonly referred to as software or courseware. The program is put into the memory of the computer so that the computer knows how to process and what to process. Software can be developed by the user or purchased commercially. Software is selected on the basis of the users' needs. For example, if a teacher wants to use the computer to drill students on math facts, software which is programmed to teach and test those facts and competencies would be chosen. If an administrator wants software that will prepare a payroll, then either commercial software programmed to do that task could be chosen, or the administrator could hire a programmer to create special software.

Optional Components

There are several peripheral devices used in vocational education that need to be mentioned. For example, in addition to basic equipment, special materials are needed when teaching computer–assisted drafting (CAD). Almost all CAD software requires an input device which is different from the traditional keyboard. Although some software programs allow manipulation of the screen cursor through the keyboard, most use an input device such as a joy–stick, mouse, or digitizer. These devices attach through one of the serial ports at the back of the computer. CAD software usually requires inexpensive output options to a parallel printer. Some require a special card with graphics capabilities. Others require a plotter.

There are also peripherals that were developed to accommodate the needs of special needs students. Microcomputers can play a dual role for students with special needs. Microcomputers can physically modify the environment so that the disabled student can gain access to their power, or they can help disabled students perform tasks denied to them because of their disability. Software has been developed which can accommodate a special learning need resulting in access to standard programs such as word processing database management and computer–assisted instruction.

Vocational educators can provide access to all students by becoming familiar with these modifications, peripherals, and software needed to circumvent a particular disability. Examples include an audio screen which reads words or letters to the user when touched, and the Kurzweil Reading Machine which reads printed material that is placed on its screen. Special software includes Large Type, a program used for poorly sighted students who need a simple, low–cost way to type in large print, and the Electronic Blackboard which is used by blind persons who need to present information to a sighted audience. This keyboard is used to enter Braille material which is then translated and displayed on the TV monitor to sighted students or instructors.

Vocational Educator Application of Microcomputers

An Instructional Tool

Vocational education teaches job–related skills. Over 75% of all workers are projected to use computers in the workplace by the year 2000. Clearly, the computer and applied computer technology should have a profound impact on the way vocational educators prepare students for work. Vocational educators should examine their curricula to determine ways to integrate this technology into vocational education as an instructional/administrative aid and as a job tool.

When the microcomputer is used as an instructional tool, the instruction built around the technology is called computer–assisted instruction (CAI). This refers to the written and visual information presented to a students in a logical sequence by a computer. This chapter cannot include the numerous ways that this technology has been and will be used in vocational education. Instead, general forms of CAI will be defined and then several examples will be detailed which illustrate implementation of this technology in the vocational education curriculum.

Within vocational education, most instructional uses can fit into five categories, each of which is described briefly below.

Drill and practice. In this instance, the computer is used to provide exercises in a specific subject area such as vocabulary or math. The computer plays the role of a drillmaster. Drill and practice exercises are especially useful when repetitive practice is needed. A good drill program is interactive, flexible, responsive and visually appealing. The exercises should be designed as a questioning episode rather than a mere series of questions. The program should tutor the student to reinforce learning when a series of questions is answered incorrectly.

Tutorial. software that fits into this category enables the computer to become the instructor. Students who use these programs may not have prior knowledge of the subject matter. These programs teach with straight text, graphics, and/or sound. Usually students move from one step to the next

when they correctly answer questions in the assessment segments of the program.

Simulation. The computer can be used to simulate work environments and for this reason the computer is of particular interest to the vocational educator. Job tasks, experiments, machinery, etc., which are not accessible in the typical classroom can be simulated by the microcomputer. This kind of software affords decision making in mock situations which might be life–threatening in a real work setting. Along with the creation of a simulated environment, the computer presents an operating model of instruction so that decisions may be enacted and results amended or modified to stress key points.

Problem solving. The computer provides the user with data and a subsequent problem which encourages the user to creatively apply the data to resolve it. Extensive data can be included in the program which would be difficult to generate, manipulate, and evaluate in other instructional settings.

Instructional games. By playing a game, students can be motivated to stay on task, learn and apply new principles, and evaluate goal–oriented strategies.

As An Administrative Tool

In the classroom. Vocational educators can use the microcomputer as an administrative tool in two ways. The first is to manage instruction, also referred to as Computer–Managed Instruction (CM), in which the computer serves as a managerial tool for instructors. It can ease the load of paperwork. The microcomputer is able to administer individualized education by prescribing activities, testing progress, providing feedback, and assigning learning activities. The vocational schools in Middlesex, New Jersey use the microcomputer in their individualized diagnostic/prescription math and reading program. The components of the program all take place on the computer. They are:

- Step 1 – Assessment by diagnostic testing,
- Step 2 – Analysis by the computer to determine areas of weakness,
- Step 3 – Selection of learning objectives to be mastered in order to correct skill deficiencies,
- Step 4 – Creation of an Individualized Student Improvement Plan for each student, and
- Step 5 – Implementation of the plan by student and teacher working together to achieve mastery of the plan's objectives.

This project is set up as a system. It begins when the student registers and takes the pretest. It ends when the student masters the competencies and progresses to the next instructional unit. This is CMI at its best.

There are less complex ways to use the computer for classroom management tasks. For example, computers can be used to manage resource centers, write letters to parents, score tests, maintain a database of test items, store student files, develop reference sheets, and publish newsletters.

In the administrator's office. Many of the administrative functions associated with managing a school have been adapted from business. As in business, management of an educational institution or an instructional program requires the processing of large amounts of information, much of which is repetitious. Generally, these administrative tasks can be completed using three types of software programs:

1. **Electronic spreadsheets.** These programs are used for tasks requiring the calculation of numbers that frequently change. The program is a template which the user constructs. It contains formulas, rows, and columns. The unique capability of this software allows the user to alter a single value or formula on the spreadsheet. Consequently, all other values which use that number or formula change automatically. In schools, it is used (among other ways) for budgeting, labor negotiating, scheduling, or calculating grades.
2. **Database management systems.** These management systems can eliminate much of the analysis and processing of paperwork that needs to be completed within a school. The programs are in actuality electronic filing systems. They are used to maintain and process records and files. Typical uses in vocational education include constructing student master files, maintaining census data, storing attendance records, analyzing competencies and tasks, maintaining health records, and keeping records of library holdings, class schedules, inventory, space utilization, and mailing lists.
3. **Word processing.** The most common use

of the microcomputer is as a typewriter: a word processor. The value of the word processor lies in its ability to electronically edit a document that has been entered into the memory. Word processors are commonly used for writing tasks that need to be continually edited and updated such as course descriptions, curriculum guides, catalogues, brochures, proposals, and reference lists.

During the past few years, educators have managed to borrow enough software and adapt it to the needs of a school to make the microcomputer a true manager of education. Future software and hardware may become more customized to the needs of educators. Currently, the microcomputer successfully manages and administers vocational education, from the individualized student plan all the way to the state level of managing and administering federal and state funds to develop a comprehensive and ever- changing system of education.

An Example of Computer-Assisted Instruction in Vocational Education

The construction industry has recently begun to use computers to process and track volumes of information, as well as build sophisticated work schedules for project management. The industry's use of the computer encompasses planning, marketing, scheduling, bidding, accounting, estimating, managing, and maintenance. The work that a construction company completes with the microcomputer should be taught in vocational education programs with the job tools that will actually be used on the job—in this case, the microcomputer.

Workers need to learn how to decide what hardware and software is right for their job before the technology is applied. Deciding what to use is a critical step in the planning process for successfully applying microcomputers to a business context. This planning process can be taught through curricula in vocational education. The planning steps involve:

1. Define your requirements—determine what you want the computer to do. Begin with broad application tasks such as maintaining inventory and completing payrolls. Next, within each broadly-defined tasks, identify specific tasks, and then prioritize them. This list will serve as a master plan for evaluating hardware and software. It is your priority list.
2. Evaluate hardware and software to determine whether they meet your needs. (See Reference List for resources for evaluating software and hardware.)
3. Determine where the information that will be entered into the computer will originate, how it will move from place to place, and the kinds of reports that will be generated with the information.

The use of the microcomputer as a job tool also needs to be taught. Within the construction industry, the microcomputer has become the major tool for managers and administrators. Job tasks performed can be easily simulated in the classroom and can lead to the mastery of microcomputer- related competencies. The construction industry uses the microcomputer for:

- Marketing—Using an automated marketing database allows for systematic communications with past customers and businesses who routinely use the company.
- Accounting and Financial Management—The templates on electronic spreadsheets can be used to perform large, complex mathematical functions to support a variety of operations, including equipment replacement analysis, cash flow analysis, bid analysis, estimating and inventory control and the relationship between these entries.
- Quick and accurate estimates—The estimate divides the job into divisions of work which need to be calculated in terms of material, labor, insurance, general overhead, and profit. Once these jobs are costed-out, they can be accessed and modified for future projects which incorporate similar jobs. In addition, a rise in the cost of materials or labor can be made once and all jobs affected by the rising costs will automatically be changed by the computer.
- Project Management—Computers permit construction companies to exceed normal barriers of simple scheduling and estimating so they can document progress and solve problems that occur during a job.
Equipment Maintenance—A schedule of preventative maintenance can be stored on the computer along with detailed records

such as fuel, filters, lubrication, licenses, and other cost items that need to be calculated per project.

As this example illustrates, the microcomputer has become a primary tool of the trade. This industry is not unique. The technology is being used in all industries to improve productivity and accountability. Vocational education students should learn how to use the microcomputer as a tool of the trade, and more importantly, learn how to make decisions about microcomputer applications in the world of work.

Implementing the Technology

To successfully implement this technology, a school must do more than purchase hardware and software and hand it over to the instructor. Successful implementation of this technology is largely dependent on its integration into existing curriculum. Some instructional programs will be created to study the technology of the microcomputer, but by and large, most instructional programs will remain the same whether they utilize the microcomputer or not. Vocational educators will look to the microcomputer as an innovative tool for teaching a previously defined curriculum.

Establishing local guidelines and priorities for this technology constitutes one phase of a planning process that each school or district should complete. Introducing computers into the curriculum creates barriers similar to other changes that schools generate. Three critical states accompanying most educational changes: planning, implementation, and incorporation.

Planning

Planning requires setting the activities in motion. Questions need to be formally asked such as: Why a computer? In what capacity will we use computers? What are our priorities? Who will use the computer? Who will be responsible for planning? What is the most cost effective way to proceed? Where will the computers be housed?

Implementation

Implementation puts the planning activities into motion. Teachers need motivation to improve curriculum. Rewards and benefits to classroom instructors must be clear—the payoff should be more than access to the technology. Microcomputers should enhance instructional methods already utilized, not increase the workload of the instructor. The way in which instructors participate must be clear. In some schools, each teacher already has quite a bit of latitude in how a subject is taught. The introduction of restrictions into that system will be resented. Enhancing the latitude of the teachers by providing them with an additional teaching tool will be appreciated and in turn, the innovation will be accepted and implemented.

Another important component to successful implementation is the role of leadership taken within the school. The presence or absence of moral support can make or break the place of the computer in the school.

Incorporation

This phase of change occurs when the computer becomes part of the teachers' and students' routine; the change has stabilized. It might be enhanced in the future, but will not be drastically changed nor considered new.

Integration of the computer into the curriculum is often referred to as the second step of computer–aided instruction. The first stage allows teachers to experiment with materials and strategies with the microcomputer as part of the instructional process. Teachers should become acquainted with the components of a computer based system prior to attempting to select hardware and software. Who is better qualified to select the materials for instruction than the classroom teacher? This should occur after they have gained confidence to creatively use this technology.

Supporting the System

There are a number of ways to support the technology in a school system. Two important aspects are teacher training and system maintenance.

Teacher training does not refer to a one–day inservice program to instruct teachers how to turn the machine on and play with a few software programs. Teachers need allotted time to ask questions and

prioritize selection criteria. Teacher training is an ongoing program which not only instructs the teacher about technicalities of the computer, but also teaches them:

- how to integrate the computer effectively into curriculum,
- how to evaluate and choose software, and
- how to use the unique capabilities of the technology to teach better.

Specifically, teachers should be able to

- determine their goals;
- pinpoint which elements of the curriculum can be taught with the computer and which can use the computer to provide supplementary material to the learner;
- determine who will use the program (teacher or student),
- which features of the computer will be used to teach certain concepts (graphics, sound, etc.);
- decide how the instructor will be involved with the computer (as a supervisor? an instructor? or not at all?);
- determine how user–friendly the computer needs to be (i.e., if all students have been working with computers in previous classes, the software does not need to be geared to the novice but if this will be a student's first exposure to the computer, then the software must be user–friendly).

After these initial considerations, vocational educators need to identify and evaluate software programs for their instructional programs. Evaluating software is more than filling out a form. It represents an important step toward integrating software into vocational education curriculum.

Maintenance of equipment is another critical component for integrating computers into curriculum. Staff and financial support are needed for hardware and updating software. Schools that successfully use microcomputers have either maintenance people on campus or a contract with a computer servicing firm. Breakdowns or delays in replacing broken equipment will limit teachers' use of computers. They will revert back to using instructional tools which do not incorporate this innovative technology.

In summary, commitment to implementing microcomputer technology in vocational education is a serious decision. It has implications in teacher training and educational strategies in the future. The decision requires the commitment of educational leadership, curriculum coordinators, and classroom teachers.

Benefits, Limitations and Questions

Microcomputer technology provides vocational educators with unending ways to interact with learners. Our teaching tools are being transformed by this technology in ways we never could have imagined a decade ago. This technology is used in creative applications such as interactive video (which builds on the strengths of the computer and the communicative powers of television), automated libraries, electronic mail, electronic networking, and desktop publishing.

Applying these technologies today will prepare us for computer refinements of the future. Artificial intelligence, for example, will soon become part of the instructional process. It is currently being used for practical tasks which could not be computerized before the technology was commercialized. Artificial intelligence programs can make recommendations and decisions based on their knowledge of subjects such as tax law, interest, or quality control principles.

Fiber optics is a technology that converts data, sound, or images to light impulses which are propelled by a laser down a thin glass thread at high speeds. The technology will be used in Minnesota for a fully interactive system that will link seven school buildings and enable them to share instructional services with all students.

As you can see, being comfortable with microcomputers as teaching tools in vocational education is a first step. These innovative teaching tools can enhance the delivery of vocational education.

Limitations of microcomputers lie in the short cuts we might take to implement the technology. Without proper training and support for this technology within each school building, microcomputers will be used in a hit–or–miss fashion. The technology holds infinite promise for those who have learned its appropriate use.

Questions Asked by Vocational Educators About the Role of the Microcomputer in Instruction

Issue 1. Why do I need a computer if it is just going to be a glorified taskmaster? Drilling exercises are already overused by teachers. Why should I encourage boring, repetitious assignments?

Thinking of a microcomputer as a drill master represents a very restricted understanding of a the microcomputer's instructional capabilities. Even when used for drilling a student, the advantages of a computerized drill can be summarized with a few key descriptors: interactive, flexible, visually appealing, and a direct and immediate provider of feedback.

In addition, the goals for competency–based education and those of a quality drill and practice exercise are very close. They are:

- Let the learners know what to expect.
- Measure the learners' performance at the end of each segment of instruction.
- Clearly show or tell learners what skill or information is to be learned.
- Provide opportunities for learners to practice skills.
- Provide opportunities for learners to test themselves.
- Provide for alternative learning strategies.
- Provide open entry to and open exit from instruction.
- Use results from the programs to improve the instruction.

The microcomputer (with good software) can provide an individualized, highly interactive, and responsive instructional systems.

Issue 2. Why would educators who call themselves good teachers put a student in front of a machine to learn new concepts instead of in a classroom with a living, breathing instructor?

The reason can be summed up in a few words: learner control. Given software that has been highly evaluated in process and content, the computer can provide students with maps of information. Users progress through material at their own pace. They can test out of units previously mastered and can receive remedial instruction on topics that are more difficult. Any portion of the instruction can be accessed without having to proceed in a linear fashion through the material.

Programs which teach new material can also be coupled with a video disk to create an interactive video system. The user can take advantage of the individualized form of instruction and at the same receive instruction from the computer and a videotape at the same time.

A good tutorial program can also provide students with instruction on topics which are not the expertise of the particular instructor or are supplementary to the core curriculum. This provides gifted students with opportunities to explore new topics on their own and also allows students with special learning needs to proceed at their own pace without interfering with the progress of the class.

CHAPTER 6

Interactive Video

Some Scenarios

A new student, moving with the caution of new students, picked up the welding torch and examined his task. As he began, the bead moved across the seam unevenly, first in a puddle, then in a line too thin to hold. Eventually, gathering confidence and skill, the student' s welding began to gain consistency.

As he finished his task, the video monitor from which he was working provided feedback on his performance. It not only told him how he had done, it also coached him on how to improve and what problems to avoid. Finally, it told him how his performance compared with those of others, both experts and peers.

In this simulation, no molten metal was actually used. The student was using an interactive video system equipped with a special, three dimensional touch space. The computer controlled the video image, the 'real time' picture of his weld, as his wand moved through the space.

A wind howling, as it always does in the North Sea, almost drowned the animated conversation between two workers on an oil rig. These technicians, engaged in safety training, were hotly contesting each other' s decisions in a realistic simulation of their working conditions, while a very real sea pounded the footings of the rig on which they sat.

Their task was to study a series of vignettes, stopping the action at critical points to analyze either mistakes or clever decisions made by technicians like themselves. The concepts were complex, the action subtle. Omissions counted as significantly as commissions as the simulated and the real technicians argued about the best way to change a set of drill bearings and analyzed the probable causes of the bearings' dismal war record.

Their interactive video system, like those installed on each of the company' s other North Sea rigs, had become a focus of very active on–the–job training. Its high entertainment value enhanced its likelihood of use as well as its effectiveness. Job related injuries were down. Productivity was up. Dealing with real issues portrayed by realistic role models in

This chapter was prepared by Dr. Kerry Johnson, a senior staff member of the Omega Corporation.

realistic situations proved effective as a training method.

The instructor was slightly nervous. After all, she had recently been appointed to her new supervisor' s job and several of her instructor would be sitting in on the class. When the regular instructor came down with the flu, she was asked to pick up a week– long seminar on the smelting process—right in the middle—and with only 24 hours notice!

After an early morning practice session with the media equipment, she felt a little more comfortable. She used an interactive video workstation to control the flow of the lesson. Its image, projected in front of the class, provided clear text, graphics, and video for the students.

As the class began, a student asked her to review a point made the day before by the previous instructor. She deftly touched the screen of her system to reveal a menu that allowed her to search instantly back to the point in the seminar which needed clarification. While playing the video segment, she related a personal experience with the segment of the process in question, suggesting shortcuts, offering warnings and cautions, and pointing out the relationships between the task demonstrated on the screen and others in the smelting process.

Later in the lesson, the instructor informed the class that it was time to practice some of the points she was making. The students broke into small groups, each around an interactive video screen, and began working through some problems. The intellectual ante had been raised. They no longer could be passive listeners. They no longer could expect to only repeat technical terms or name the steps in a process. Instead, they were in charge. The students now needed to use the information their instructor had been discussing and demonstrating. Part of the feedback from the videodisc system informed them how much their choices cost the company for each task relative to how much it should have cost. Other parts pointed out safety tips. Even interpersonal relationships, the interactions between technicians, could be part of the feedback. The level of debate, the quality of the student interactions, and the degree of peer learning continued to climb as the session progressed.

The instructor observed everything as she circulated the class room. Her excitement was as obvious as that of her students.

These three scenarios demonstrate the range of interactive video in several different ways. In one direction, these scenarios demonstrate the technology' s usefulness in situations ranging from independent learning to instructor–led classrooms. In another, they demonstrate the range of skills that can be taught: psychomotor, affective, and/or cognitive. The scenarios suggest levels of content complexity—from a focus on a single objective (welding) to a focus on a complex set of objectives (smelting). In addition, they illustrate the range of use from instruction to evaluation, and from performance to performance appraisal.

These three short scenarios exemplify the many forms and uses of computer–based interactive video (CBIV) that will be explored throughout this article. The goal is to glimpse the potential of the medium by examining current examples of CBIV in vocational education.

A Description of Interactive Videodisc

Computer–based interactive video (CBIV) combines two of the most powerful new learning technologies—video and computers—into a single, integrated system.

A basic CBIV system contains several components:

- microcomputer
- video monitor
- input device—keyboard, touchscreen, mouse, etc.
- videocontroller
- videodisc player—memory storage device.

Video and computer signals are different from each other. The critical technical advance of CBIV, therefore, is the ability of the system to mix both signals into a single, integrated signal. This is accomplished in different ways by different manufacturers. However, the end result is video and computer images on the same screen at the same time. In practice, it means that a video picture, still or motion, can be combined in any way with graphics and text from the computer. Text from the computer can be overlaid on video to highlight concepts or vocabulary. Diagrams can be added to existing video by students as they work through

problems, or, questions can be embedded in visual sequences and controlled by students' input.

The second major technological breakthrough of CBIV is the storage system—the videodisc and videodisc player. Videodiscs are optical storage devices that look like shiny 12" vinyl phonograph records. The rapidly spinning disc is read by a laser that senses a series of pits in the videodisc's surface. It is a highly efficient storage medium allowing 54,000 still frames or pictures (30 minutes of video) to be stored on each side. In addition, two sound tracks allow for the storage of 60 minutes of high quality audio.

Videodiscs feature two major advantages: 1) they last indefinitely because the disc makes no physical contact with a needle or recording head (the laser reads the disc using a light beam); and 2) they are randomly accessible. Random access means that any one of the 54,000 frames can be instantly brought to the screen. Each has a commuter address and can get called either as a result of student responses to questions or tasks (as in the welding example) or by instructor choice (as in the third scenario). Random access capability distinguishes videodisc from videotape as a training medium.

As a training or educational technology, CBIV is in transition because ongoing improvements are being made in videodisc and other storage technologies. For example, compact disc technology has improved in the last few years to the point where visual, audio, and text may be combined on the smaller CD's to provide CD–I—compact disc interactive. Just as compact discs have allowed consumers to obtain high quality audio in their homes, the development of CD–I will open new markets for interactive technologies.

An advance in storage technology that uses smaller discs is DVI— Digital Video Interactive. Developed by GE/RCA, this DVI system is very intriguing because it brings video and computer images together by digitizing and compressing the video—thereby putting each video picture under complete computer control. The significance of this breakthrough is that visuals can now be completely manipulated by the learner. For instance, portions of a video image can be "picked up" and moved around the screen, or stored as a student's response to a question, giving greater flexibility both for producers and students. Through video compression, DVI overcomes the major limitation of CD–I by providing full–motion video, where the technology of CD–I only allows for still pictures.

Instructional Applications of Interactive Video

Transitions in the technology will continue in the foreseeable future. In the meantime, new and interesting approaches to instructional design are evolving almost as rapidly as the technological advances.

Consider, for example, the three scenarios of instruction introduced earlier. Each involves a sophisticated set of instructional interactions. The essential instructional design component of each, and all interactive video systems, revolves around an organized visual/audio/text database accessible to learners and instructors in a variety of ways, for multiple purposes. A learner, an instructor, or groups of individuals use the system to organize, analyze, evaluate, and synthesize information. They establish a dialogue with the information. They explore. They question, and they are questioned.

Individual Use of the Technology

The first example, involving the oxyacetylene welding simulation, was designed for individual use. A single student enters a simulated environment and attempts a particular set of tasks. In this case, it is a physical task that involving psychomotor skills. The welding practice is also the kind of specific instructional experience that fits within a more complex lesson or curriculum. Welding which is taught traditionally gets practiced rather untraditionally.

There are numerous examples of individual skill–oriented training for which CBIV is a useful medium. Tasks involving expensive equipment or materials that are potentially dangerous or involve major disruption of the workforce can be taught effectively using CBIV.

Machinery operation is an appropriate use of CBIV. Teaching students to operate and maintain assembly line equipment is expensive for either schools or corporations. The tools change regularly and are expensive, yet students learning on obsolete tools are at a clear disadvantage. If the operation involves consumable components such as chemicals or disposable parts, it is expensive merely to stock

supplies. Simulated practice sessions using CBIV can either eliminate or reduce the need for practice with actual materials.

It is possible to simulate working with dangerous materials and equipment. Students will eventually need the opportunity to work with such materials, but they can gain valuable initial experience simulating those activities, exploring first hand the consequences of carelessness or inattention to detail before they are confronted with the actual materials and results.

Two excellent examples of this kind of CBIV application are a chemistry course developed by the University of Illinois and a set of physics lab experiments developed by the University of Nebraska. In each case, previous teaching has been done using computer–based instruction. The addition of high quality video enhances the realism and impact of the experiments. Teachers could continue to use the interactive video materials to demonstrate chemical reactions of physical phenomena. The more powerful use, the one for which they were designed, is to allow students to work through the experiments themselves, predicting and observing results and controlling experimental conditions.

A third example of individualized interactive video instruction is a medical math program developed by the University of Maryland for the United States Navy Health Sciences Command. This program is designed to remediate math skills of the Navy corps in a realistic, job–related way. Calculating dosages, estimating weights and measures, and converting metric measures are examples of the skills that are woven into scenarios with real patients under realistic conditions. Corpsmen accuracy is important since patients can die without proper treatment, and the simulations make this point vividly.

Training can also have negative consequences if it disrupts a workforce or delays a customer. Consider, for example, the amount of time expended on customer service training (on the job) in a retail environment. Experienced sales clerks must either stop selling in order to monitor trainee behavior, or spend additional time outlining sales behaviors between customer encounters. Consequences or choices made by the student cannot be allowed to disrupt a potential sale. However, completeness and complexity can be built into a CBIV simulation. Customer reactions, sales data, and performance results can be programmed into a dynamic, realistic, and seamless system. Interactions with colleagues can also be woven into the complex fabric of the simulated workplace so that the impact of the student' s performance on fellow workers can be demonstrated in the feedback.

A good example of this type of application is provided by the British firm, B & Q Retail, Ltd., a major retailer much like Sears or J.C. Penney. They developed an interactive sales training program that allows employees to simulate the experience of the sales floor. Of particular interest in the B & Q program are the demonstrated interactions among various sales personnel and their reactions to the behavior of team members. It quickly becomes clear to the new employee, who naturally seeks the approval of co– workers, that performance is measured not only by how well you sell, but also by how well you perform the aspects of your job—e.g., creating good displays, maintaining orderliness of stock, or managing paperwork.

Interactive video has been used in retailing in the United States for different purposes. The U.S. retailers quickly realized its benefits as a direct information and sales tool. For instance, shoppers can select wallpaper, buy shoes, or even create their own car using interactive video. Dealers and shopkeepers have installed such systems in the stores. Buyers simply run through various combinations of choices until they are ready to make a purchase. Even the purchasing itself can be done on the system.

The next extension of that concept, one presently being tested by J.C. Penney, for example, is to allow customers to access the interactive video from home via their cable television and touch–tone phone.

Small Group Use

The rationale for CBIV in individual instruction carries over to small group use. Indeed, much of the material designed for individual learners can be used, sometimes more effectively, by groups of 2–4 students working as a team.

One benefit of group use is that peer teaching is encouraged and facilitated. Instruction can be designed to create opportunities for cooperation, competition, or discussion—all leading to a more realistic simulation of the actual workplace and encouraging more desirable workplace behaviors.

Consider Scenario 2 from above. Shell designers created a series of vignettes depicting realistic events that can take place on an oil rig. Technicians study these materials during training before they are assigned to the rig, but they also are encouraged to use them when they are actually stationed in the North Sea. While they might originally use the materials in the classroom independently, in the field they often choose to use them in pairs, discussing choices, arguing about the accuracy of the scenario, or relating the simulated action to real, personal experiences in similar situations.

A major benefit of such peer teaching is that it overcomes one of the shortcomings of the medium—namely, the inability of any available instructional technology (unlike the live instructor) to spontaneously generate new examples. Tremendous storage capacity, such as that available through videodisc, is still not unlimited storage capacity. Variations on an instructional theme, spontaneously developed by two or three students arguing over a specific decision, enhance the learning opportunity. They expand it. They make it even more real.

Two recent examples demonstrate the power of CBIV to evoke enthusiastic reactions.

Decision Point is a management simulation on CBIV designed to teach decision–making skills to managers. After being introduced to their fictitious company and accepting a new job as Associate V.P. of Sales, the users of Decision Point encounter a randomly presented series of situations requiring their decisions. The students can get more information before making a decision by asking someone else in the firm, or by looking at data and calculating alternatives. These decision points are based on frequently encountered situations in business and are presented realistically.

Four senior managers, two each from two major automobile manufacturers, recently challenged each other on Decision Point. As the two teams competed on their separate systems, they were somewhat skeptical about CBIV as a teaching medium. Three hours later, their attitudes were different. They had discovered the value of deliberating and debating decisions in this simulated environment. It had questioned their basic procedures, management techniques, and values. Each person gained insights into the decision making process, and each participant enjoyed the competition with his/her real–life counterpart on the other team. Consider the prospects for that kind of experience for junior or senior high school students!

In another example, a recent episode of TV' s St. Elsewhere featured a story about the potential of interactive video to teach medical decision making. One of the major characters, a second year intern, was having difficulty making decisions even though she knew relevant facts. Her previous solitary struggle was highlighted and eventually helped by working with fellow interns on an interactive video system. The simulation forced them to discuss decisions, to argue about various diagnoses, and to weigh the dire consequences of mistakes—all designed to improve their reaction times in an emergency room situation. These stories are not evaluations, but they suggest an engaging effectiveness for interactive video and future directions for the technology.

Instructor Use

Instructor use of CBIV or videodisc in the classroom setting has gained moderate acceptance thus far. Lack of material and equipment are major barriers that have been limiting. Scenario 3, outlined earlier, represents the most complete and dramatic use of the medium in the classroom.

Another, less dramatic classroom use of videodisc is as a random access audio–visual device. That is, the videodisc player, without a computer, can be used to project visual and audio information to the classroom. This use of videodisc has been particularly important in areas such as science and technology. For instance, companies such as Videodiscovery are creating generic discs containing audio visual materials—slides, video, sound, graphics—in areas such as earth science and biology.

Implementing the Technology

Interactive video, like other innovative instructional media, requires careful implementation. It is a powerful medium, as demonstrated by the examples. Some research claims that 40–60% reductions in the time required to achieve acceptable performance levels can be achieved. Interactive

video has been shown to be engaging—focusing the learner' s attention, crystallizing difficult concepts and expanding learning options. Interactive video requires thoughtful application and measured use if it is to be integrated effectively into an education or training curriculum. Several issues that need to be addressed will be explained in detail below.

Appropriate Use

The issue of appropriateness pertains to understanding strengths and weaknesses of the medium itself, of building strengths into the design, of instructional programs, and of incorporating those strengths into the flow of instructional materials. Large quantities of complex, multi–media data can be stored in a CBIV system. Media selection becomes a constant issue of both design and use as a full range of visuals, text, and sound are made available. Appropriateness is determined by relating the nature of the content to the aptitudes of the learner. The principal challenge for the designer is balancing this complex relationship of content, learner and media.

Appropriateness of the medium also becomes an issue when choosing instructional strategies. Instructors need to be aware that CBIV is useful for drill and practice, simulations, and complex concepts requiring a variety of explanations from several perspectives. It is also a powerful assessment device judging visual and auditory recognition as well as textual recognition of concepts. As an assessment tool it can store student responses and provide ongoing feedback to both student and instructor.

Curriculum Fit

Interactive video must fit into the curriculum. Many present uses of CBIV originated from a desire to try the medium as opposed to meeting curricular requirements. Research and development needs may have taken precedence over curricular needs. Interactive video is now generally acceptable, and large numbers of high quality programs are commercially available. These two assets, acceptability and availability, should permit more careful curriculum planning with CBIV to fulfill needs and solve problems.

In response to this growing level of acceptance and awareness, several firms are developing generic course materials—not specific to a given institution. but appropriate to broad curricular areas. For instance, On Line Computer Systems, Inc. has produced two comprehensive courses for its new GATE (Global Approach to Technical Education) curriculum. The first of these courses, Digital Electronics I & II, is highly interactive and flexible. They are broadly designed to fit most vocational electronic programs. The materials combine sophisticated use of videodisc and CD–ROM technology for course delivery but respect traditional curriculum requirements.

Another exemplary approach to the 'curriculum fit' problem is the Job Skills Education Program (JSEP). Sponsored by the Army Research Institute and developed by Florida State University, this program attempts to integrate the task training needs of more than 100 military occupational specialities into a single, comprehensive package. Much of the material is currently computer–based instruction, but interactive video components have been planned.

Both examples (GATE and JSEP) focus on understanding generic curriculum needs and designing materials that fit. Portions of each can be used independently, but the intent is for each program to work either as an entire curriculum or along with an existing curriculum.

Cost–effectiveness

The third major issue in implementing interactive video has to do with scale. CBIV is expensive to produce, averaging from $10,000 to $30,000 per finished hour of course materials. Purchase prices for commercially produced programs range between $1,750 and $2,000. In addition, the necessary hardware systems are priced in the $5,000 to $10,000 range. Such costs must be justified in terms of student contact cost ratios—costs per student contact hour. Thus, the concept of scale becomes a significant factor in determining cost effectiveness.

Scale is a relative term, of course. Some of the skills which need to be taught in a vocational/career education curriculum involve direct costs that can be considerably higher than simulated costs. For example, it is prohibitively expensive to allow students to try out their skills with real equipment and materials in such vocational/technical fields as toxic waste management and air traffic control. Simulated

exercises and experiences become relatively inexpensive in these cases.

It also appears reasonable to look beyond or across individual institutions when developing interactive video materials. In many professional training situations, notably medicine and nursing, institutions are forming consortia, designing and producing programs to share. Since production costs remain constant, the obvious net result is that the cost per student contact hour decreases as the number of students and the amount of course material increases.

Quality

A shortage exists of research and evaluation on the effectiveness of interactive video, but theoretical and intuitive bases may be used for judging quality. Quality programs are not simply those with high production value; they also must represent effective instructional design strategies. This is particularly true when the learner is operating independently. Every option must be carefully considered; nothing should be left to chance.

Decisions regarding quality are speculative; the research base only hints at what works. Designers must try new approaches. They must draw on research from other fields—communications, computer science, and advertising, to name a few—and they must weave this research together with knowledge that has evolved from the early days of computer–based instruction.

Quality is an important issue because the CBIV production process consists of a large number of integrated phases and tasks. Maintaining quality and management control for such a complex instructional system is a difficult task. It requires great attention to detail and responsive monitoring systems.

Potential Obstacles to Successful Implementation

Three major concerns hinder the rapid, widespread use of interactive video—cost, compatibility, and complexity. The first, cost, has been covered in some detail by the preceding narrative. Early advocates of CBIV suggested that it would ultimately be an inexpensive medium since it would reduce many traditional costs. In part this is true, but not in the way these pioneers envisioned. Presently, the major savings are realized by cutting the time necessary to train an individual on a given task.

The cost issue is also more complex than it first appears. The complexity is manifested in the less tangible issues of quality and scope. As the medium is applied in more situations, by various producers, new uses are developed and new instructional goals are achieved. Because CBIV can teach things no other medium can teach, because it can combine experiences and abstract concepts in ways beyond the capacity of the normal classroom, new learning can take place, learning perhaps not considered feasible in traditional training. It may also be that teaching these new tasks has additional cost saving potential.

Cost is also a relative issue. One example of the relativity of cost is found in Ford Motor Company's use of interactive video for sales and service in their dealer network. Ford technicians now have a visual, full–motion field manual that can be used to provide background experience or a step–by–step walk–through on a difficult repair job. In that case, every hour of technician time saved results in greater overall productivity and more satisfied customers—difficult costs to measure.

The second major concern pertains to system compatibility. The industry has not stabilized around a single hardware/software standard. Each manufacturer has its own standards. In addition, software vendors continue to develop new authoring tools that work only on specific hardware systems. Since it surprises no one that this lack of system compatibility creates a major marketing dilemma, there have been industry–wide efforts to identify standards.

The third major concern is the complexity of courseware production. Some producers in business, government, and education have overcome this problem. They are producing a lot of high quality CBIV. IBM, for example, in a new catalog of interactive video courseware for its Infowindow system, lists almost 300 courses developed by a wide range of companies and universities. The IBM example means that in addition to an increased number of producers, there are an increased number of options for those who want pre–manufactured material.

For many institutions that would like to develop courseware, obstacles remain. The major problem with development complexity is that it requires cooperation from a number of individuals who have

little or no experience working together. Designers, subject matter specialists, programmers, and video producers must speak a common language and collaborate in an environment filled with ambiguity, complexity, and deadlines. It is a challenging situation.

Conclusion

Technical skills, social skills, and cognitive understanding have each been taught effectively using interactive video. Certainly cost, compatibility, and complexity make producing CBIV difficult, but the outcomes are generally worth the effort.

Quality programs are now being produced and distributed so that the burden of production is shared and costs are being brought under control. Compatibility is becoming less of an issue as software producers create programs capable of operating on a variety of machines. In addition, the research literature on videodisc design and production is growing to the point of usefulness.

In short, computer–based interactive video is becoming accepted as an effective method of delivering vocational and technical instruction. The examples offered throughout this article give evidence of its widespread use. The range of uses continues to expand, as does the number of producers and the amount of high quality product.

In part, CBIV presents yet another instance of the chicken and the egg phenomenon. If more vocational educators began to demand and use more CBIV, more products would be developed, and relative costs would likely drop. However, many schools are reluctant to make initial investments in the hardware necessary for CBIV until more program products are available. Time will tell if this apparent dilemma can be resolved. Given the power of the technology as an instructional tool, positive resolution of the dilemma seems important.

CHAPTER 7

Integrated Information Technologies

Current and emerging information technologies likely to change the ways we work and learn are described in this chapter. A brief scenario is presented about how learning might transpire in schools where the technologies are utilized more fully. This is followed by discussion of:

- new information technology characteristics and capabilities,
- instructional designs the technology makes possible, and
- factors affecting the technology's implementation.

A Scenario

At 8:30 a.m., John, a student at Washburn High School, starts the day by logging onto one of the computers in his home room. News announcements flash by about an honors assembly this week and the advisability of getting flu shots. He is reminded to report for his annual school physical at lunch time. John reviews his electronic mail. His friend Bill wants ideas for a science project. Cynthia wants to have lunch, and there's a love note from a "secret admirer" that is not to be taken seriously. Crank messages are common among high school students. John types his replies and prints out a schedule of learning activities he is expected to complete today. The schedule, prepared by his home room teacher and advisor, is based on weekly teacher/student conferences, computer maintained records of each student's previous performance, and curriculum requirements. Home room class is English, one of four courses (English, science, math, and social studies) that everyone has to take. John has not made definite career plans, but his electives are in vocational and technical education because he is interested in drafting and construction systems. The core curriculum is designed around common content themes. This week is Greek week: English is about Greek literature, social studies is about Greek history, math is about geometry concepts originating in Greece, and science is about Greek versus modern conceptions of the universe. With the aid of the computer, elective courses sometimes follow the themes as well.

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Today English class is largely discussion. All week the class has been reading and viewing Greek tragedies and identifying common themes. These do not interest John as much as how the plays were staged, but he realizes that he needs to know their content if he is to understand how theaters were designed to accommodate them. However, his attention perks up during the discussion of the Greek god Hephaestus, son of Zeus. Hephaestus was known as the master craftsman and grant architect for Olympus.

Social studies is spent doing research in the learning resource center (LRC). John has decided his social studies term report will be on the design and construction of Greek theaters. He asks the LRC computer for information about Greek architecture, especially that related to theaters, and several references are suggested. The display indicates which are available locally, which are at other schools or the public library, and which are checked out. John orders a book from the public library that will be delivered the next day, sends an electronic mail message with a request for a book he cannot find, and opts to search the on–line encyclopedia.

Greek architecture and theatres are separate topics in the encyclopedia and John looks up architecture first. The only information there that may be related concerns amphitheaters. He types "amphitheaters" and the computer displays every topic in the encyclopedia in which the word occurs. He reviews these topics, but only the topic Greek theatre has information of real interest. So John makes some quick notes using the computer's word processing software and copies them, along with the entire Greek theater section of the encyclopedia and the section on Greek architecture discussing amphitheaters, to a floppy disk. John also searches a visual data base of several thousand images on Greek architecture. He is particularly interested in the Corinthian columns that appear on many Greek structures. Their ornate features appealed to John much more than the channeled Doric columns or the fluted Ionic columns. He uses a special device to electronically transfer to his floppy. He checks out a videocassette on the five orders of Greek architecture to watch on the family's VCR and will review the information recorded on the floppy on his home computer. Another video program will be transmitted by satellite overnight from a national library and recorded off the LRC's receiving antenna for John to pick up tomorrow.

In math, John works with Lillian, his assigned partner today. Computer records indicate their math performances are similar. As the computer tutors them on certain geometric theorems and proofs, they take turns and help each other. At the end of the lesson they play a game where they compete with each other and the machine. The computer adjusts its level of play so it answers questions about as well as they do. At one point, it detects a bug in John's reasoning and interrupts play to explain his misconception—displaying and graphically illustrating each step in applying the theorems to construct a geometric figure.

In science, the class is divided into teams of three. Each trio also is assigned on the basis of previous performance. The teacher drops a feather and a rock and invites the class to advance hypotheses about why the feather takes longer to fall. Teams then place a feather and rock in a vacuum tube and calculate the time each object falls in this non–resistant environment. The entire experiment is simulated on the computer, saving laboratory equipment and expendable materials. Teams assemble apparati by touching actual pictures of objects and pointing to where they are to be relocated on the computer screen. When they run their experiment they see full motion video of the objects falling. They use the computer's clock to record time. The class then discusses different team findings.

John has his physical after lunch. His data are entered into the computer and automatically are sent to the Centers for Disease Control to be pooled with data on millions of other children. The data pool is used to develop health statistics, perform studies on the relationships between children's physical conditions and disease risks, and monitor the spread of disease. After the physical, the school nurse displays a map showing flu incidents in the country this week and last, noting dramatic increases in the immediate area and suggesting vaccination. She also shows John the average life expectancy of persons with similar physical condition and life style. John asks how smoking would change his expectancy, the nurse makes this hypothetical change in his record, and a new expectancy is displayed.

John's afternoon drafting class involves using computer aided design software. John employs an

electronic pen and tablet to draw images on the computer screen which he has the machine enlarge, shrink, and rotate. Sometimes he creates an exact duplicate of all or part of a drawing and modifies it. His current task is to create cross sectional views of simple three dimensional structures. Given his current interest in theaters and Greek architecture, he has retrieved some of the images of Corinthian columns that he had previously stored. John enters three dimensional views of the column into the drafting software. After doing a cross section of a column, he has the computer check his work. It first draws the cross section itself and then compares the cross section John did with its own, pointing out discrepancies. Most discrepancies John could understand, but one failed to make sense to him and his instructor, and a "bug alert" was filed with the software developer. John doesn't mind the computer correcting his work. In the future, he will create his own isometric view of the capital (top portion) of the column and ask the computer to match his drawing. That is when he will check the computer's accuracy.

John's last class, construction systems, is unusual because he learns skills that he then instructs a machine to perform. Today he is part of a team responsible for designing and building a light–weight, pre–fabricated run of stairs for low–cost housing units. Once the team is satisfied with the design, precise measurements will be programmed for the automated manufacturing laboratory. Practically, this imbues him with the psychomotor skills necessary to practice a craft, and the cognitive design and programming skills needed for automated production. It also provides an environment where feeling and thought converge. John is learning several aspects of construction systems.

Information Technologies

The learning events just described are grounded more in the present than the future. Most of the educational applications exist already, although many are experimental or not widely used. The information technologies that make them possible and that are of primary interest in this chapter include microcomputers, optical disks, and networks. Each is discussed below. Computers are emphasized because of their pivotal role in linking together the other technologies. When integrated, the technologies have capabilities that are more than the sum of their parts. Indeed, more visionary applications result when these technologies are viewed as unified systems.

Microcomputers

Computers have been around for some time, but microcomputers have not. [See Chapter 5.] Microcomputers make it possible for people to have more computing power on their desktops than entire universities had twenty years ago. The nature of the information stored in computers, their memory, processing, and information input and output mechanisms are key to their successful application.

Information. Computers use digital rather than analog information. Analog information is in the form of continuous waves. Light waves reflecting off objects and sound waves traveling through the air which enable us to see and hear are termed analog. Audio and videotape recordings and radio and television broadcasts involve the storage and transmission of information in analog format. Digital information, on the other hand, is in the form of the presence or absence of electrical impulses. Different impulse patterns can be given specific meanings that computers have been designed to interpret. For example, the pattern 01000001 (where 1 is the presence of an electrical charge and 0 is not) is interpreted by most computers to be the letter A. Computer designers have agreed this pattern will represent A just like persons who use Morse Code have agreed that three short sounds (dots) represent the letter S and three long ones (dashes) represent the letter O. Each pulse in a digital information pattern is called a bit and a pattern of eight bits makes a byte. Computer designers have decided that different numbers and letters will be represented in different, unique eight–bit patterns. Digital and analog information is not compatible. This must be taken into account whenever computers and analog media, like video, are used together, as was noted in Chapter Six.

Memory. Computers have the capacity to store digital patterns and display them as characters we understand. There are two types of computer memory. Random access memory (RAM) stores information inside the computer as patterns of electrical charges. Since information stored in RAM disappears when the computer's power is turned off,

there is also external, permanent storage involving the use of disk drives. These can record electrical charges in RAM as patterns on magnetic disks and read these magnetically stored patterns back into the computer as electrical ones. The capacities of computers' internal memories and those of external magnetic disks are described in terms of the number of characters or bytes they can store. This author's computer has 640 kilobytes (640,000 bytes) of RAM and stores information externally on a 10 megabyte (10,000,000 byte) magnetic disk.

Processing. Most information devices simply record and play back information and have limited, if any, capacity to change it. For example, videocassette machines do not create new information from that originally recorded. Computers, however, are designed specifically to manipulate information. They can take the bit patterns representing 1 and 2 and produce a new one representing 3. They have to be instructed (programmed) to do this. Essentially, these instructions set switches inside the computer to transform electrical patterns in different ways. Patterns must reside in RAM to be transformed and usually they get there by being read from magnetic disks or by someone entering them from the computer's keyboard. (Pressing a key causes the pattern of electrical impulses representing its character to be transmitted to RAM.) Once in RAM, information can be displayed, erased, changed, and/or saved on magnetic disk.

Input/output. Information technologies usually input and output information in only one or two ways. For example, most videocassette recorders only accept information from video cameras or from other videotape machines and display it on television sets. Information can be input computers using keyboards, disk drives, mice, light pens, touch screens, and voice recognition units. Mice and light pens can be used to draw and change graphic displays or select options on the screen. Touch screens allow option selection by finger pointing, while voice recognition units enable the computer to respond to spoken instructions or even record sounds on magnetic disks. Digital audio devices enable computers to play back these recordings or to sound out characters and words originally typed from the keyboard. These options provide the computer with a varied interface.

Optical Disks

Although magnetic disks can store lots of data, they are inadequate for storing large amounts of audiovisual information. In the case of images, the characteristics of each dot or pixel on a screen must be stored digitally. Will a pixel be turned on or off? If on, what is its intensity and color? Most screens are made up of thousands of pixels, so much more memory is required to store and display a picture than a screen full of individual eight–bit characters. Since motion pictures actually are a series of individual still pictures displayed at a rate of thirty per second, they require even more storage. Optical disks have the extended storage capacity needed. The key to applying this technology is knowing how information is encoded and read from these disks, the varied formats they have, and related technologies.

Encoding/reading. Optical disks are either mastered or recordable. Mastered disks are plastic with thin metal surfaces. They store information when microscopic pits are engraved on the metal in patterns that reflect light differently. Special facilities are required to engrave pits on master disks which are used to manufacture duplicates. Once information is encoded on disks, it cannot be changed without creating new masters. Thus, mastered optical disks can be read only; it is not possible to write or record new information on them. Information is read by moving a laser beam across the disk's surface and interpreting the light patterns reflected back. Since there is no physical contact between the reading device and the disk's surface, the disks never wear out and it is possible to read information constantly from one point on a disk without doing damage. Recordable, but unerasable, optical laser disks exist that can be written to once and read many times. In addition, recordable/erasable disks are beginning to appear.

Formats. Different formats result when different standards are used to encode information.

- Compact disk—digital audio (CD–DA) is a mastered format where pits are engraved to be read as bit patterns that produce sounds. These four and three quarter inch disks can be played on compact disk players available from any stereo store and can contain about seventy two minutes of high fidelity audio

per side. Even more audio can be stored if fidelity is sacrificed.

- Compact disk—read only memory (CD–ROM) is a mastered format where pits are engraved to be read as bit patterns representing characters and, sometimes, images. These disks, also four and three quarter inches, are read by CD– ROM drives designed for use as computer peripherals. Over 540 megabytes or roughly 150,000 text pages or 1000 images can be stored on a single side. Motion images are jerky when this format is used without additional supporting technology because the drives cannot transmit the enormous number of bits representing the individual motion pictures to the screen fast enough.
- Videodisc is a mastered format where the pits are read as analog wave forms, reducing the requirement to digitally store and transmit information about individual pixels. This format can store 54,000 still pictures, thirty minutes of full motion, or a combination of motion and stills on one side of a twelve inch disc. Most videodisc players are used alone, but some can be computer controlled. Since videodiscs are analog and computers are digital, information from the disc and computer has to be displayed on separate screens unless the computer is configured with special circuit boards. When so configured, computer displays and videodisc images are overlaid on one monitor.

New optical disk formats and other, similar technologies are emerging.

- Compact disk—interactive (CD–I) is a new format that has been announced. It is to be like CD–ROM, except a single disk will be able to display characters, still and motion pictures, and play audio. Motion will not be quite full and will fill only a quarter of the screen.
- Digital video—interactive (DV–I) has recently appeared that gives full screen digital motion to images stored on CD–ROM. It involves adding a special device to one's computer. Digital information is recorded about pixel groups instead of individual dots. If the device receives information that pixel one is red and pixel ten is blue, it interpolates that pixels two through nine are red also. Since less information must be recorded about each picture, there is less to transmit and enough data can be sent to display true motion.
- WORM disks are compact digital disks and analog videodiscs on which information may be recorded without mastering, but once recorded they cannot be changed. The physical characteristics of these disks are very different from other optical disks and special drives called WORM drives (write once read many) are needed to use them.
- Readable–erasable disks are compact optical disks that can be recorded on, erased, and re–used. These disks, which are just beginning to appear, store information digitally.

Developers are striving to create digital imaging that includes motion. If all information (numbers, characters, graphics, audio, and actual pictures) is digital, the need for separate analog video and digital computer displays or for computers modified for video overlay will be eliminated. Moreover, digital images can be enhanced computationally to produce better pictures and, once digital picture data is read into a computer's RAM, users can manipulate it. For example, they might enlarge pictures electronically or cut and paste different picture parts to display composite images. This is not possible with analog videodisc technology. It is not now easily done with actual digital pictures of real objects, although it is commonly done with simplified graphic representations of objects.

Networks

Microcomputer and optical disk technologies are intended for individual use. All the digital and analog information needed has to be stored locally unless these devices can communicate with each other or with central information sources. Network technology allows this. Knowledge about network configurations and information transmission is essential for understanding how this technology might be used.

Configurations. There are computer and television networks. Computer networks pass digital information among machines by running a cable

between each computer, using existing phone lines, or both. Since telephones transmit analog signals, each sending computer needs a device called a modem to convert its digital information to analog and each receiving computer needs a modem to convert it back. Some networks have central computers that function as either "servers" or "hosts." Servers channel communication and let users utilize software on the server (such as a word processing package) and hardware (such as a printer) the server controls. Hosts give users even more resources, often letting them search data bases on the host or use its computing power to write their own programs. Television networks usually send analog video information from a central source by satellite to stations having receiving antennae. They either immediately retransmit these programs or record them on videotape for later broadcast. The programs also could be recorded on WORM videodiscs, but the process is expensive.

Types. There are local area and large regional/national computer networks and broadcast and dedicated television networks. Local area networks link computers within a building or campus by cable. A central computer, usually a micro, functions as a server, reducing the need to have certain software or hardware on every computer in an institution. Larger networks use phone lines. Their central computers are generally very large mainframes functioning as hosts. Broadcast television networks, such as those for commercial and public television, have receiving stations with powerful transmitters to rebroadcast programs over large areas. Dedicated networks have less powerful means of retransmitting, usually just to television sets on cable within a single campus or building. Often local computer and dedicated television networks share a common cable. Some cable channels are used for computer communication; others are used for video.

Instructional Designs

Although new information technologies are interesting, the learning environments they make possible are more intriguing. The technologies are mere vehicles for delivering instruction, both bad and good. Knowing the technologies' vast and varied capabilities is one thing; designing instruction to take advantage of them is another. Traditionally, instructional programs have been categorized as drill and practice, tutorial, or simulation. Drill and practice programs provide repetition and reinforcement of basic knowledge students have already acquired, while tutorials guide them in learning new content. Simulations provide life like situations in which students apply what they have learned. When microcomputer, optical disk, and network technologies are married, it is possible to provide these same programs and more. The technologies allow new instructional designs previously not possible or feasible. These designs can be classified as scenario based, hypermedia, and parallel systems.

Scenario Based Designs

These designs expose learners to scenarios packed with video and graphic images. Learners typically are given a goal and must perform tasks to achieve it. Performance while interacting with the scenario is monitored in the background. Remedial instruction is either given at the end of the scenario, if the goal is not attained, or during interaction, if too many errors are made. Scenario based designs differ from traditional simulations. First, the worlds in which learners interact can be realistic or fantasy. Second, more events are portrayed with images instead of verbal descriptions. Third, input devices such as mice, touch screens, and voice recognition units are used to allow more immediate interaction. Finally, didactic lessons are built in that teach content required to interact successfully. Most simulations merely provide short explanations of how the real life problems they portray might be solved, not in-depth instruction. Scenario based designs have deeper and more direct links between theory and application.

A series of emergency medical programs exemplifies scenario based instruction. They are used on workstations having microcomputers, videodisc players, and touch screen monitors. Physicians view different video episodes showing a patient whose condition changes over time. They gather information and prescribe therapies by touching selections on the screen. When the case concludes, physicians can repeat the scenario, see an explanation, compare their decisions to experts, view highly structured lessons explaining the clinical content needed to help the patient, or access references. Another example is the U.S. Army's STARS program. Soldiers play

a video game where they travel back in time to give General Patton a message. The tasks performed to attain this goal require use of basic skills. Soldiers are automatically branched to remedial lessons when errors are made and the lessons must be completed successfully to resume play. The game is an invisible diagnostic test with supporting instruction.

Hypermedia Designs

These designs provide learners with knowledge bases and related retrieval tools. Original information can be searched, not just references. The information may be textual, graphic, pictorial, or some combination. Each display in the knowledge base functions as a menu to other displays and contains cues to additional information. Learners use these menus to move and manipulate information displays, mark information for later retrieval, reference personal notes, or search related topics.

An electronic textbook is an example. Highlighted text terms indicate additional information is available. Positioning the computer's cursor on any of these terms causes a menu to pop up with options to view images on videodisc, see definitions, or search for the terms or related topics elsewhere in the text. Notes are made by typing messages in "windows" learners can cause to appear. A mark is typed at the point in the original text where the note is to be referenced and the note can be retrieved by positioning the cursor on the mark. Blocks of text can be copied onto magnetic disks to create personalized knowledge bases.

A second example is a program teaching pushcart assembly. The initial menu is simply a graphic of the entire cart. Positioning the cursor on any part of the cart causes other displays of assembly diagrams and/or written instructions to appear. A third example is a hardcopy text with barcodes enabling the use of a small computer and barcode reading wand to retrieve or display related images on videodisc. A similar program overlays icons on the video pictures. A mouse is used to select icons that display other visuals on the disc showing the original image at greater magnification or at different angles.

Parallel System Designs

These designs involve constructing complementary teaching and testing programs around a common knowledge base. The knowledge base can be accessed in different modes such as information, instruction, or test. In information mode, text and visuals are retrieved. In instruction mode, additional strategies are evoked that teach the retrieved content. In test mode, questions about knowledge base content are presented. The knowledge base, instructional strategies, and test questions reside "along side" each other. They exist as separate computer files, but are cross indexed so learners can shift between modes. One learner might explore a topic in information mode, decide to be tested on it, and, depending on results, opt for instruction. Another might choose to be tested on the entire knowledge base and then review only certain topics by accessing information or being taught.

Although few (if any) systems have thus far been designed expressly for use in either tell me, teach me, or test me modes, one system in medicine has some of these features. AIRheum is a microcomputer based expert system developed at the National Library of Medicine that diagnosis rheumatic diseases. The system renders multiple diagnoses or indicates it lacks sufficient information. Findings supporting each diagnoses are displayed; additional information needed to confirm the primary diagnoses or an alternative is indicated. Users can ask the system to display the rules used to reach a decision or show and tell them more about diseases and clinical findings. Additional text and videodisc images are displayed in response to these requests. Users can access the latest literature on these diseases any time by temporarily evoking another program that automatically searches data bases at the National Library of Medicine. Citations retrieved are automatically downloaded to the microcomputer's magnetic disk and users resume using AIRheum where they left off. A complementary system, AILearn, is being developed that uses the expert system's videodisc images and decision rules to teach symptom recognition and clinical reasoning.

Implementation Factors

Many issues must be confronted when deciding to adopt, adapt, and apply new technology. Some of the more important concern costs, compatibility, software availability/quality, teacher knowledge,

and the political and social changes new technologies engender.

Costs

Most information technologies are relatively expensive when first introduced, but costs drop as they become used more widely. Declines are likely to be greater and sooner when the technologies are intended for both consumer and educational markets. WORM and DV–I technologies are still new and relatively expensive and CD–I is still under development. Microcomputers and videodisc players have been around since the late seventies and early eighties and their costs have declined dramatically. High quality videodisc players now run $1800 and the cost of mastering videodiscs is about $1500 dollars (down from $15,000 initially). Disc costs, still somewhat expensive, must be weighed against benefits. In the long run, new information technology is smaller, cheaper, and better, but the savings that accrue from using it are less evident than its sticker price.

Videodisc players provide all the communication features of slides, filmstrips, film, and videocassettes. Given appropriate programs, they can provide all the instruction it could take four machines to present. They are more portable and easier to install and use than a complement of other media. Disc storage capacity and its capability of being read without physical contact reduces space requirements and replacement costs. Production costs are lower when discs are composed of all still images or when existing films and videotapes are converted to discs. Some organizations team up, each providing a share of the visuals and paying its portion of mastering/production costs. Often production is unnecessary because teachers can generate their own computer–based lessons incorporating images on existing discs. Some companies are creating generic discs of visual content in different subject domains expressly intended for such "repurposing."

Compatibility

Most new information technologies are not compatible with those in existence, or, initially, with each other. This is understandable since they have capabilities that were not possible to achieve in earlier media, and innovations occur rapidly in the early stages of technological development. Sometimes companies hope to set de facto standards for new technology by dominating the marketplace. Other times they agree to standardize their products in advance, so each is insured a share of the market, and more compatibility results. When companies produce independently often two de facto standards result. Apple and IBM are two standards for microcomputers and VHS and Beta are two standards for videocassette recorders when market share is the measure. Generally, the more companies subscribing to a standard, the more likely its success. For example, most manufacturers of videocassette recorders have agreed to make VHS machines. Even though Beta devices have been marketed for some time and have a substantial user base, the technology's future is uncertain.

A number of major CD–ROM manufacturers have agreed to what is now called the "High Sierra" standard. Most videodisc players marketed in the U.S. can play one standard format disc, but often use different player control codes. Thus, most optical videodiscs can be used alone with any machine, but when under computer control they may be incompatible, depending on the computer and player brands used or how the computer was programmed. Since the different circuit boards allowing overlay of computer and video displays are not compatible, programs using this feature have less compatibility. Videodisc technologies currently are relatively standard, but new, incompatible formats continue to appear.

Software

People will not buy hardware until software is available, but software typically cannot be developed until hardware exists. Consequently, there is seldom any software when new technologies are introduced. Moreover, early programs tend to be unimaginative, often mimicking those of older technologies, because producers are unaware of or do not understand the new media's capabilities. Early motion pictures were stage plays and the first instructional television programs were lectures. Sad to say, beginning instructional videodisc programs were essentially lectures as well. Program developers for new technologies are not immune from the learning curve, and some hardware manufacturers have realized its importance. Since software sells hardware, manufacturers have be-

come more prone to partner with software designers, letting them experiment with prototype machines to create programs, insuring software availability when the devices are introduced.

Knowledge

New technologies tend to be more powerful, programmable, and complicated than the individual technologies they replace. In order for these to be used successfully people need basic, non–technical knowledge about how the technology works, how to design programs, and how the technologies can be applied. Unfortunately, media often are introduced to potential users without adequate training and with lots of hype that complicates understanding. It is no wonder that poor quality courseware and misapplications result. When computers are involved, it is erroneously assumed programming skills are required, but teachers and students need to learn how to use information technologies as tools. These technologies are becoming greater parts of everyday life and it is increasingly necessary to use them to find facts, maintain records, keep financial accounts, create reports, or even be entertained and taught. User friendly application software, including authoring systems requiring no programming knowledge to create interactive computer–video lessons, makes it easier to use the technologies as tools.

Political/Social Change

Technologies upset old power centers and create new ones. For example, many university, business, and government employees were at the mercy of central computing departments until microcomputers were introduced. Micros changed the nature of organizational computing systems, but also eroded the power of central departments since people did not have to depend on them. There sometimes were animosities between those advocating organizations to invest more in mainframes as opposed to micros, a situation that is changing as large and small computers have become more integrated. Some employees embrace new technology while others do not. They may have vested interests in old technologies or fear changes that may result from technology applications. Sometimes technology eliminates jobs and creates others, but it almost always changes the ways people do things. Most of these changes make organizations and individuals more effective and efficient, but readiness to accept change must be taken into account.

Conclusion

Technologies described in this chapter are presently used in many settings. Military training uses videodisc and microcomputers. Encyclopedias, dictionaries, and other reference materials are published on CD–ROM. Many businesses and government agencies have local area computer networks, and there are dedicated satellite television networks regularly providing continuing education programs to different hospitals. A national "educational utility" has been proposed that will use all the technologies to deliver instruction to subscribing schools. Videodisc and compact disk materials would be distributed by mail, while videotape and computer programs would be distributed by phone and satellite to participating schools. The latter would be downloaded to central computers and video broadcast receiving centers at each school and redistributed to student workstations over local computer/video networks. The work stations would have microcomputers, videodisc and videocassette players, and CD–ROM drives. The utility would be both a means of publishing and distributing electronic media and a resource for monitoring and managing student instruction. It would provide instant access to current materials, reduce communications costs with a central information source, and allow local curriculum control.

New instructional designs the technologies make possible are information rich and highly interactive, providing unprecedented learner control over the content to be mastered and the sequence and pace of instruction. Moreover, the control is highly virtual, with the technology responding almost immediately to user requests. There also is a high degree of interconnectivity among subject matter topics and different kinds of interaction. Learners can engage in surrogate travel through cities, the human body, and the insides of machines when provided with appropriate data bases of visual images. They can instantly explore information in electronic encyclopedias and use the computer as an intellectual tool to manipulate information, write reports, design objects, or create art. The designs are indica-

tive of the unfolding importance of information retrieval both in ongoing job performance and initial learning. But the designs are not for everyone. In many circumstances it may be better to use traditional instruction or intelligent tutoring systems that monitor user responses, make inferences about what students know, and gear instruction to their levels of understanding with less learner control. The problem is not only deciding when to use the new designs the technologies allow, but also determining when the technologies themselves are appropriate.

New technology is turbulent. Its adoption always involves some risks, but failure to adopt involves risks as well. Some organizations are involved in work that is so technical and complex that they have no choice but use new technologies early. Others can be more conservative, watching market forces set standards. Ironically, if too many people exercised too much caution, no standards would develop. However, organizations without a need to innovate early might benefit from adopting practices of those that do. Government agencies and businesses involved in high technology often maintain staffs that monitor technological developments. They work with new technologies on a small scale, usually in research and demonstration projects. Testing several competing technologies, most of which eventually will be abandoned, reduces the chances of error when decisions to adopt technology on a wide scale are made, making the extra expense of these multiple small scale tryouts worthwhile. Perhaps schools need a similar scheme for experimenting with new technologies. One thing is certain, there is much to learn about technology applications in vocational education.

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